The Engineer

NOVEMBER 7, 1958 — 28 ESSEX ST., STRAND, LONDON, W.C.2 — TWO SHILLINGS

TIMKEN
tapered-roller bearings
ON WORK-ROLLS

Wherever a high standard of accuracy has to be maintained under high-production conditions, Timken tapered-roller bearings show up to the greatest advantage.

It is significant therefore that Timken bearings are used on the work-rolls of

all the wide continuous strip mills in Great Britain

for the production of Steel Strip

HOT MILLS

Ten-stand continuous hot-strip mill
at The Steel Company of Wales Limited, Abbey Works.
Continuous hot-strip mill at John Summers, Shotton.
Six-stand continuous hot-strip mill
at Richard Thomas & Baldwins Ltd., Ebbw Vale.

COLD MILLS

Five-stand Tandem cold mill
at The Steel Company of Wales Limited, Trostre Works.
Three- and four-stand Tandem mills
at The Steel Company of Wales Limited, Abbey Works.
Five-stand Tandem cold mill and other mills
at The Steel Company of Wales Limited, Velindre.
Four-stand continuous cold mill at John Summers, Shotton.
Five-stand Tandem cold mill
at Richard Thomas & Baldwins Ltd., Ebbw Vale.

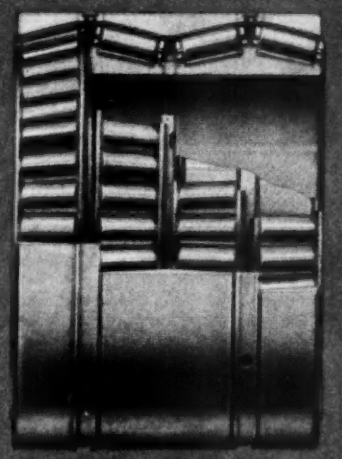
TIMKEN Regd. Trade Mark

TAPERED-ROLLER BEARINGS
MADE IN ENGLAND BY

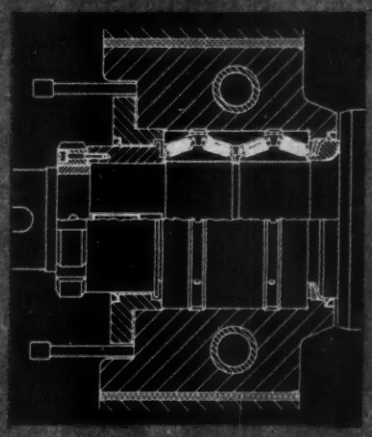
BRITISH TIMKEN
LIMITED

DUSTON, NORTHAMPTON (HEAD OFFICE)
AND DAVENTRY, NORTHANTS

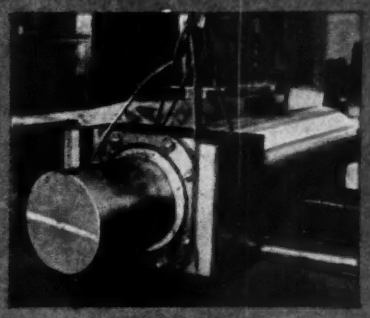
British Timken Limited have been awarded the
GRAND PRIX
for excellence of their exhibit in the Precision Mechanics Section at the World's Fair, Brussels



THE TOUGHENED CORE obtained by using the finest quality case hardening nickel alloy steel.



A CHARACTERISTIC INSTALLATION showing the basic simplicity.



QUICK AND EASY MOUNTING permitted by the loose fit between bearing bore and roll neck.

Turbo Blower for oil refinery in Venezuela. Photograph by courtesy of Messrs. Daniel Adamson & Co. Ltd.

STEEL CASTINGS

Intricate castings of various sizes and qualities to suit customers requirements are continually produced in the Hadfields foundry.

Special supervision coupled with distinctive workmanship and technical dexterity are embodied in the manufacture of Hadfields castings, produced in carbon low alloy, manganese and other wear resisting steels, stainless and heat resisting steels.

HADFIELDS
SHEFFIELD

HADFIELDS LTD., EAST HECLA WORKS, SHEFFIELD, ENGLAND

THE ENGINEER

Established 1856

No. 5363 **NOVEMBER 7, 1958** VOL. 206

EDITORIAL CONTENTS

Leading Articles

" Off-Peak " Electricity . . . 711
Value of Conferences . . . 711
The U.S. Naval Building Programme . . . 712
Industrial Health . . . 713
Vacations Abroad for Students . . . 713

Articles

100 Years Ago . . . 713
Shell-Roofed Hangars at Abingdon . . . 714
Institution of Civil Engineers . . . 715
Public Works Exhibition. No. I . . . 717
1958 Motor Show. No. II . . . 721
Sir John Cockcroft Nuclear Power for the Propulsion of Commercial Shipping . . . 729
Production Control by Computer . . . 731
Synthetic Rubber Plant at Hythe . . . 733
Rolling Mill for Nuclear Fuel Elements . . . 735
Fast Pilot Launch " Leader " . . . 736
Eynsham Bridge . . . 737
Licensing and Insurance of Nuclear Installations . . . 737
Fuel Research . . . 737
Miniature Uniselector for Automatic Switching . . . 738
Marine Engine Building . . . 738
Micro-Spot Cathode-Ray Tube . . . 738
British Motor Show in Lisbon . . . 738
Westfield Opencast Coal Site . . . 739
Truck-Mounted Concrete Machines . . . 739

Continental Section

V. E. Gough Friction of Rubber. No. II . . . 741
Lightweight Radio Compass . . . 743
Lightweight Drainage Pump . . . 743
Irkutsk Hydro-Electric Station . . . 743

American Section

Sixth International Congress on Large Dams. No. II . . . 744
U.S. Navy Ship Motion Simulator . . . 747
Gas Turbine Evolution . . . 747

LETTERS Ministries and the D.S.I.R. . . . 726

BOOK REVIEWS . . . 726

OBITUARY Sir William Halcrow . . . 728

NEWS AND NOTES Industrial and Labour Notes . . . 740
Personal and Business . . . 748
British Patent Specifications . . . 749
Forthcoming Engagements . . . 750
Advanced Engineering Courses . . . 750

INDEX TO ADVERTISERS : PAGE 143 **CLASSIFIED ADVERTISEMENTS : 136**

NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

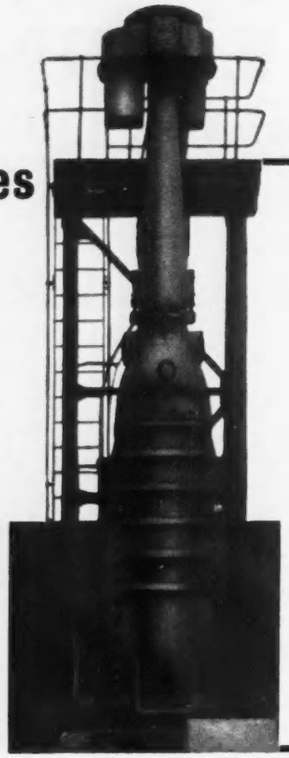
SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

Published every Friday by
MORGAN BROTHERS (PUBLISHERS) LTD., at 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone : CENtral 6565

Northampton
relies on Bailey's valves

At the Northampton Power Station, Bailey valves control the water supply for the cooling system. Backed by more than a century's experience the company provides a standard range of high quality valves from 2 to 54 inch bore for pressures up to 150 p.s.i., for the control of oil, water, steam or gas. Advice is gladly given on all kinds of applications and a special Contracts Department is maintained to deal with valve schedules on large contracts anywhere in the world.



A FEW OF THE INSTALLATIONS USING BAILEY'S VALVES

Malacca Power Station
Basra Power Station
Baghdad Refinery
Mond Nickel Refinery
Penang Power Station
Selkirk (Manitoba) Power Station
Barbados Power Station
Barri Sudan
Colenso Power Station
Kuwait Refinery
Roxburgh Power Station

MOST OF THE C.E.G.B. POWER STATIONS AND A.E.A. STATIONS INCLUDING

Battersea
Bold
Bradwell
Calder Hall
Chapelcross
Hams Hall
High Marnham
Littlebrook
Marchwood
Northampton
Nottingham
Staythorpe
Stella North
Stella South
Willington

Bailey's VALVES

SIR W. H. BAILEY & CO. LTD. HEAD OFFICE & WORKS: PATRICROFT, MANCHESTER

TELEPHONE: *Eccles 3487-8-9* GRAMS: *Beacon, Telex, Eccles.* LONDON OFFICE: Selinas Lane, Dagenham, Essex

SLUICE VALVES · PRESSURE REGULATORS · TEST PUMPS · TURNSTILES

TGA BAI I

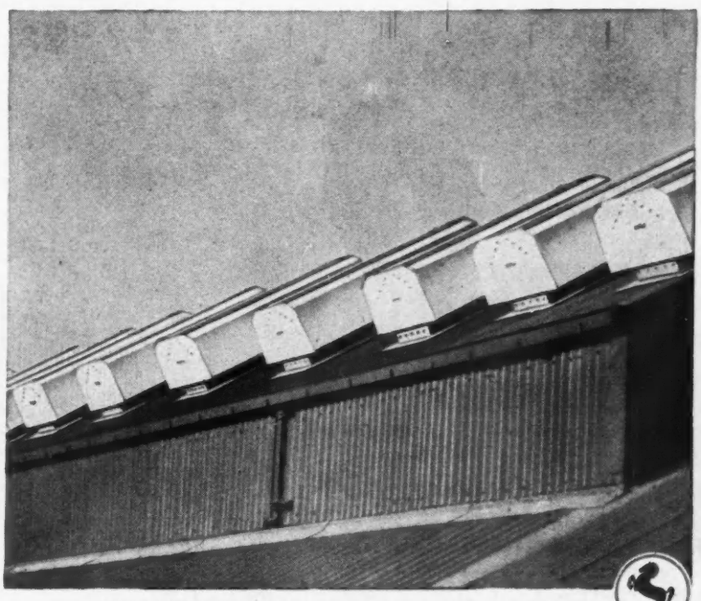
TANGYE INDUSTRIAL HEATER
TANGYES LIMITED
SMETHWICK · BIRMINGHAM

AD No. 54

36 contracts from Pilkington Bros. Ltd endorse the supremacy of

COLT VENTILATION

Time and again, industrialists large and small place repeat orders with Colt. And for three good reasons. Colt ventilation systems depend in the main on internal convection currents—*not* external forces—and are therefore little affected by the vagaries of the wind. Colt offer an unparalleled range of ventilators. And most important, every Colt recommendation is based on a thorough analysis of the building, plant and process either from a site survey or drawings. Such thoroughness influences firms such as Pilkington Bros. Ltd. It will impress you, too. Ask your secretary to send for a free manual to Dept. S31/11A

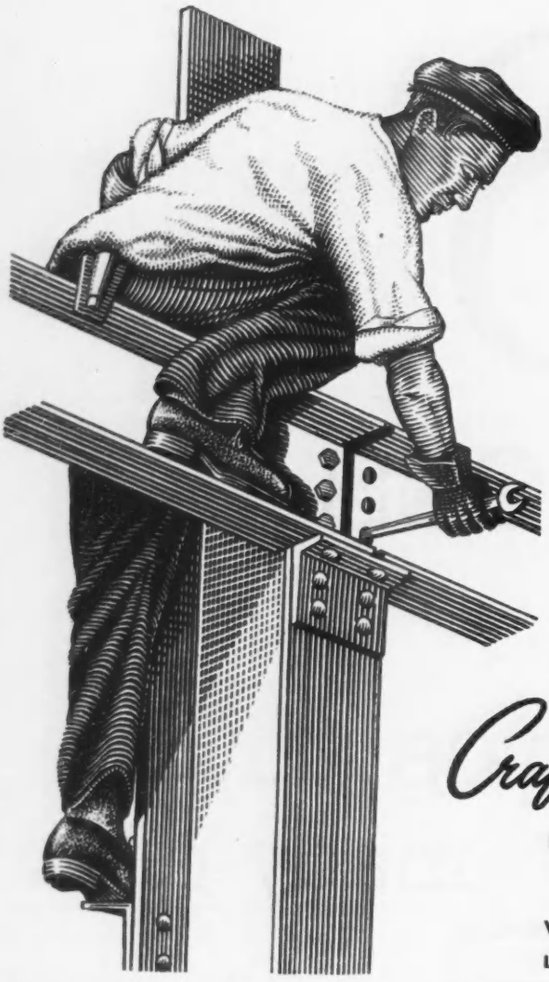


COLT S.R.C. 3080 VENTILATORS AT PILKINGTON BROS. LTD., ST. HELENS, LANCASHIRE

Among the 12,000 major Industrial Organisations using Colt equipment are:

56 contracts: *de Havilland Aircraft Co. Ltd.*
7 contracts: *Richard Thomas & Baldwins Ltd.*
25 contracts: *British Oxygen Co. Ltd.*
14 contracts: *Ferranti Ltd.*
29 contracts: *National Coal Board.*
20 contracts: *Ruston & Hornsby Ltd.*
15 contracts: *Dorman Long & Co. Ltd.*
15 contracts: *Hoover Ltd.*
22 contracts: *Lever Bros. Port Sunlight Ltd.*
9 contracts: *Joseph Lucas Ltd.*
19 contracts: *Philips Electrical Industries Ltd.*
21 contracts: *The Plessey Co. Ltd.*
6 contracts: *Smith Clayton Forge Ltd.*
35 contracts: *Taylor Woodrow (Building Exports) Ltd.*
20 contracts: *Courtaulds Ltd.*
13 contracts: *Gloster Aircraft Co. Ltd.*
32 contracts: *Imperial Chemical Industries Ltd.*
14 contracts: *W & R Jacob (L'pool) Ltd.*
11 contracts: *The Steel Company of Wales Ltd.*
14 contracts: *John Summers & Sons Ltd.*
10 contracts: *Vandervell Products Ltd.*

COLT VENTILATION LIMITED · SURBITON · SURREY · TELEPHONE: ELMBRIDGE 0161 (10 LINES)



Craftsmanship comes the hard way...

If over 90 years spent in the design, fabrication and erection of structural steelwork means anything—it means you can place this work in our hands knowing it will progress smoothly to completion. Large job or small, we have the resources to handle all your needs. We welcome the opportunity of serving you.

Craftsmen in steel ..

ESTABLISHED 1867

WALKER BROS LIMITED *Structural Engineers*

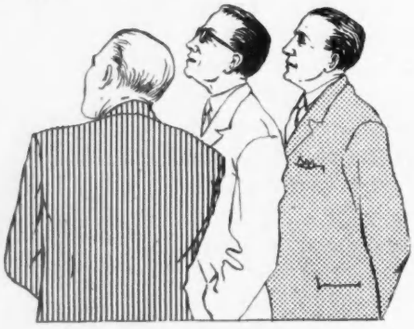
WALKER BROS. LTD. WALSALL, STAFFS, Telephone: WALSALL 3136
LONDON OFFICE: 66, VICTORIA STREET, S.W.1 Telephone: VICtoria 3926

Finished machined forgings

a h ! y e s

Cull forgings are good—really good. That cuts machine cost to a minimum—as they have a real understanding of the 'out-of-the-ordinary' job. Yes get in touch with Culls—they're the best people.

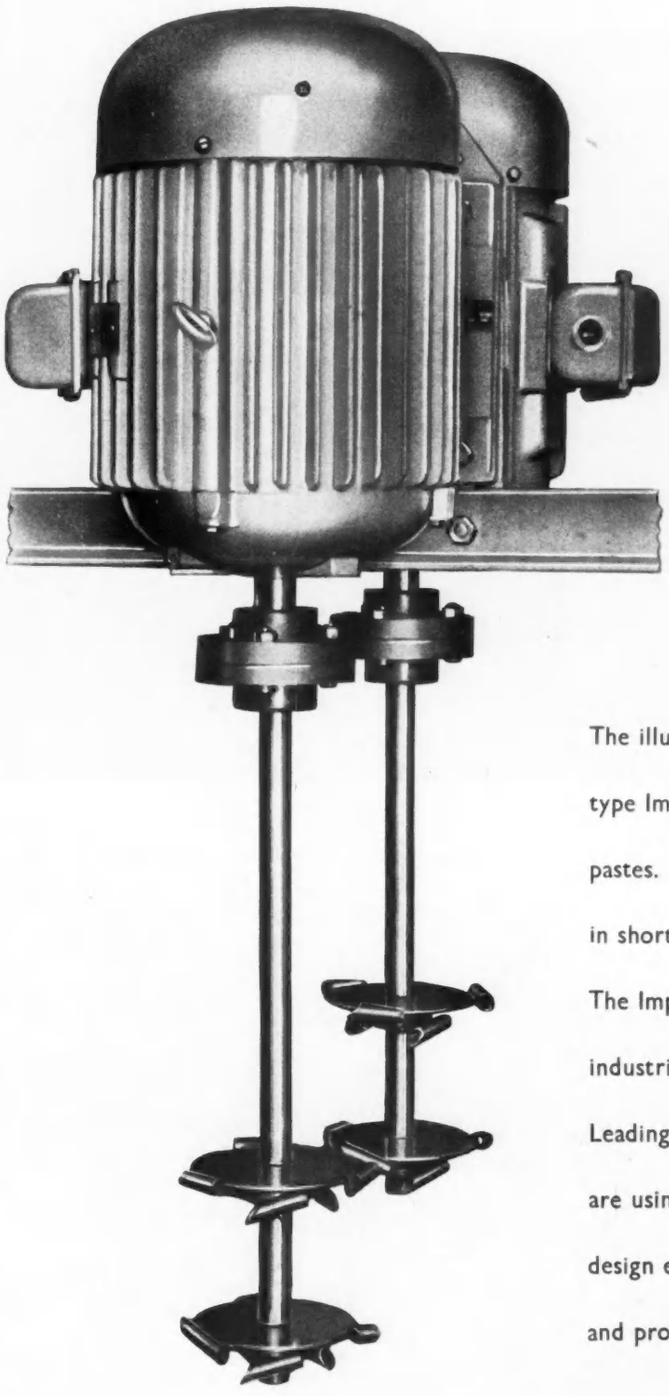
The forgings illustrated were finished machined at Cull's own factory, after final heat treatment and were subjected to crack detection. Cull inspection is 100% on all products.



CULL

W. B. CULL & SONS LTD.
Head Office & Works
TENNANT STREET, BIRMINGHAM, 15
Phone : MIDland 6048-9 Grams : CULANSONS, B'HAM
Works also at :
POWKE LANE, OLD HILL, STAFFS.

if its different then send it to "Culls"



Controlled Mixing with PLENTY IMPELATORS

The illustration shows a pair of Plenty industrial type Impelators as supplied for the mixing of graphite pastes. They give a more efficient mix in shorter time on one of the most difficult applications. The Impelator can be adapted to meet any industrial mixing problem, whether large or small. Leading firms in this country and the U.S.A. are using Plenty Impelators and the services of Plenty design engineers with conspicuous success and profit. Fullest details gladly sent on request.

Some Users—

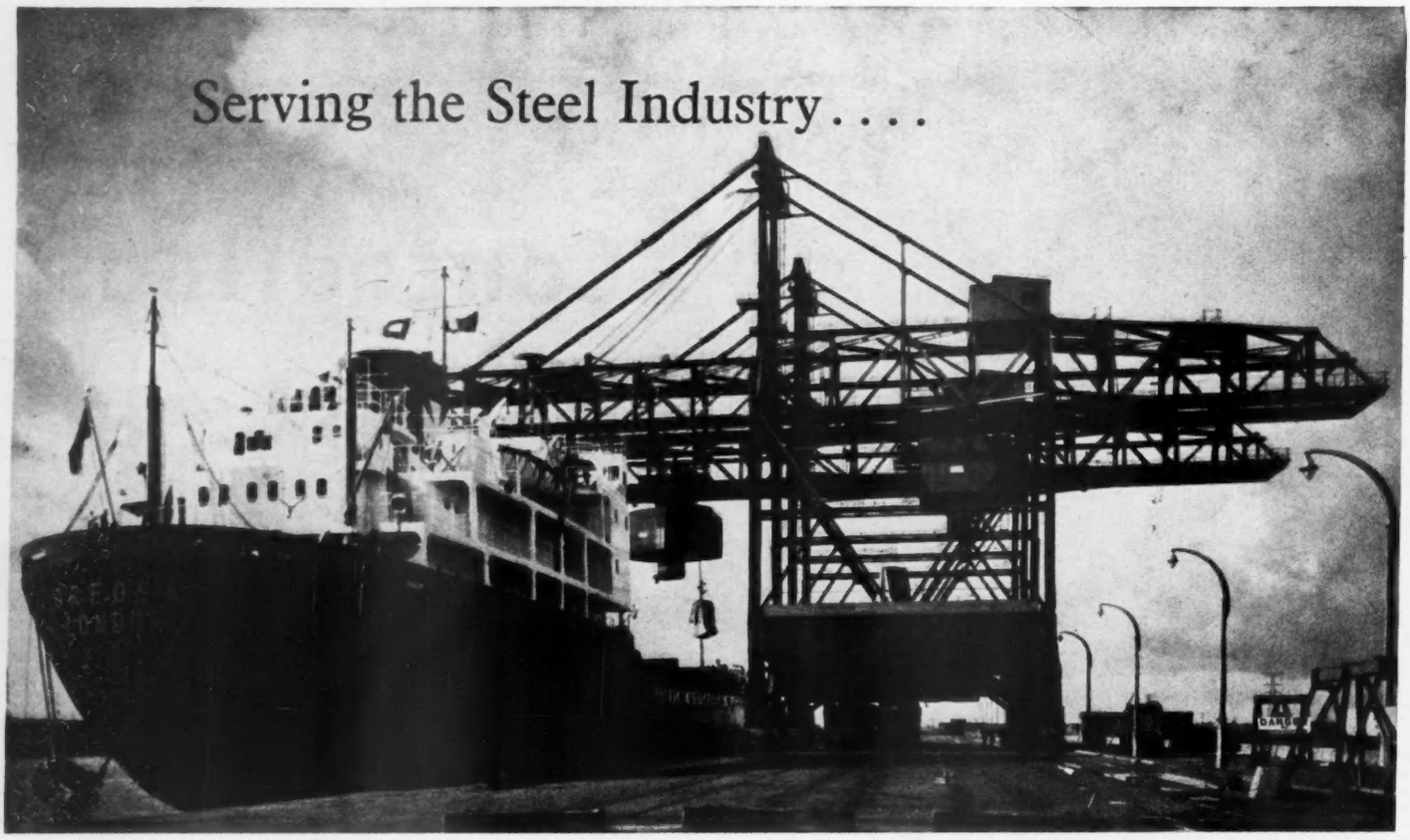
Imperial Chemical Industries Ltd.
Caltex.
Cadbury Bros., Ltd.
Colgate-Palmolive Ltd.
Guest Keen Iron & Steel Co., Ltd.
English Clays Lovering Pochin & Co., Ltd.
Scribbans-Kemp Ltd.
British Nylon Spinners Ltd.
Kodak Ltd.
Ever-Ready Co. (Gt. Britain) Ltd.

PLENTY & SON Ltd.

Eagle Iron Works,
NEWBURY, BERKS, Eng.

Telephone: NEWBURY 2363 (4 lines)
Telegrams: PLENTY, NEWBURY

EN



From ore unloading, hot metal pouring and section handling to shipping the finished product, the Clyde-Booth range covers the field of heavy materials handling for the Steel Industry.

Manufacturers of

Ore Transporters
Steelworks Cranes
Diesel Rail Cranes
Dockside Cranes etc.

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.

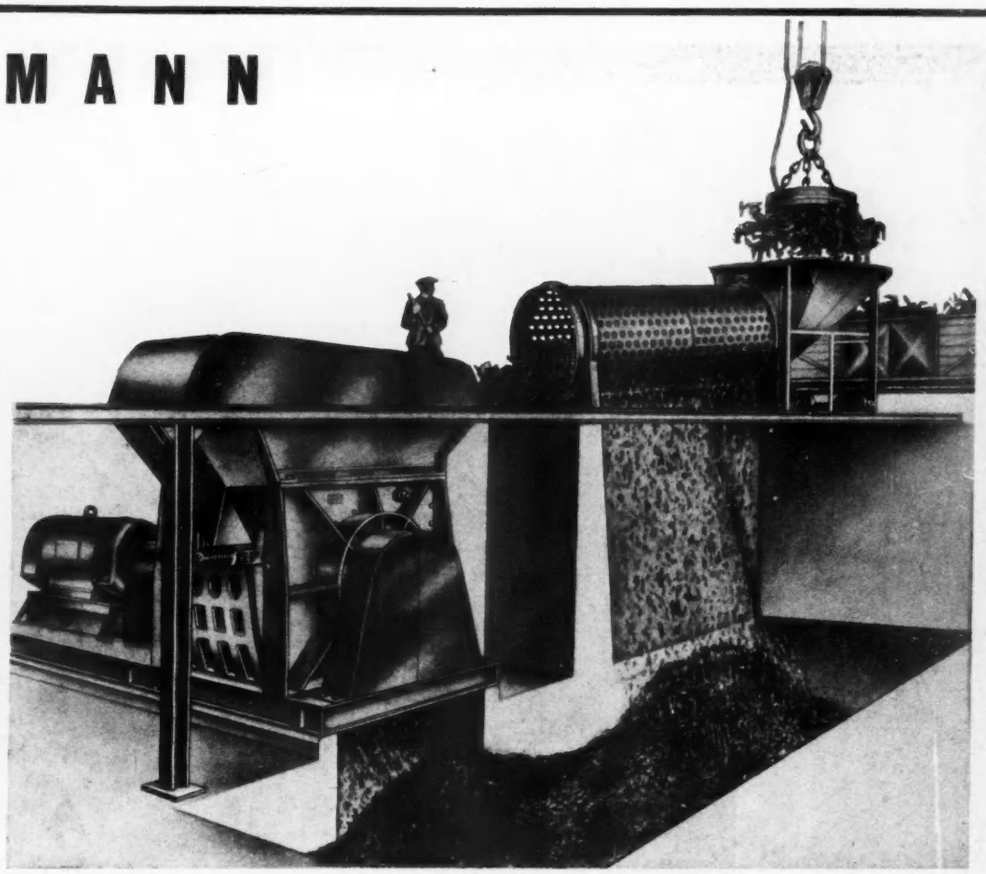
Incorporating:

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Telephone: Pudsey 3168 (6 lines). Telegrams: "Cranes," Rodley.

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Telephone: Holytown 412 (6 lines). Telegrams: "Clyde," Motherwell

LINDEMANN

Beater Crushers for turnings transform bulky and matted steel turnings into shovelable chips for being charged into blast furnaces. Due to novel type charging system by means of revolving screen, hourly output is increased up to 20-30 tons, and even more.



Our Agents in the British Isles
MOFFAT & BELL LTD.
170 Piccadilly, London, W.1
Tel: Hyde Park 9551
466 Royal Exchange
Manchester 2 Tel: Deansgate 5131

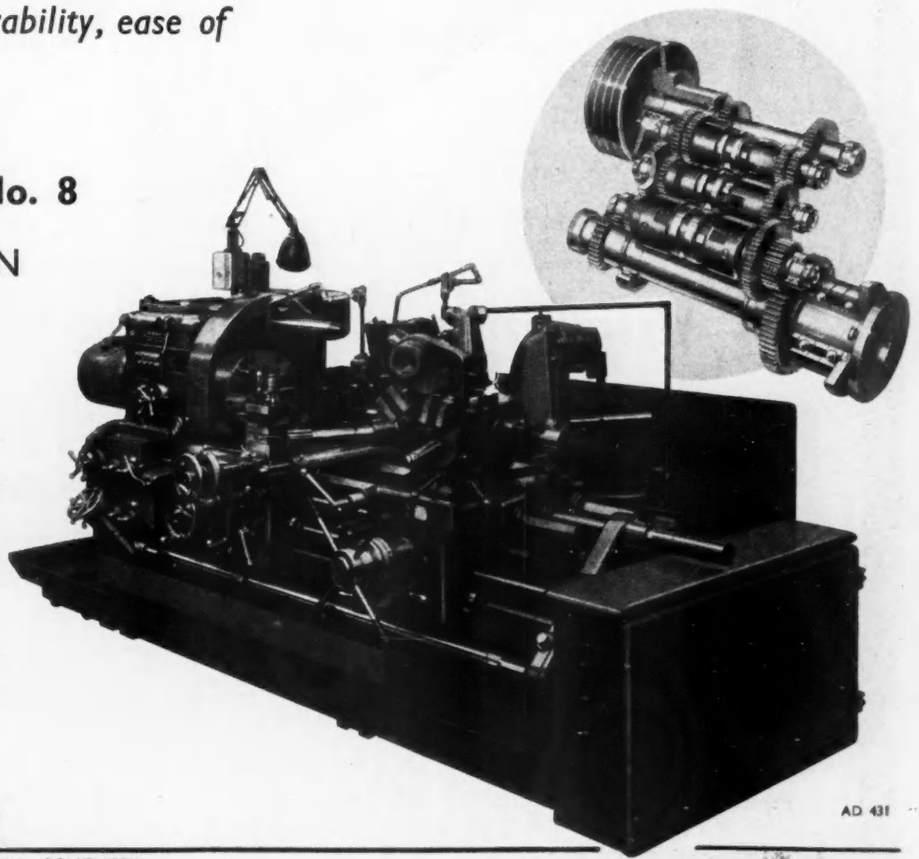
LINDEMANN MASCHINENFABRIK GMBH DÜSSELDORF GERMANY

every modern feature is incorporated to ensure high production, accuracy, durability, ease of operation on the—

HERBERT No. 8

PREOPTIVE COMBINATION TURRET LATHE

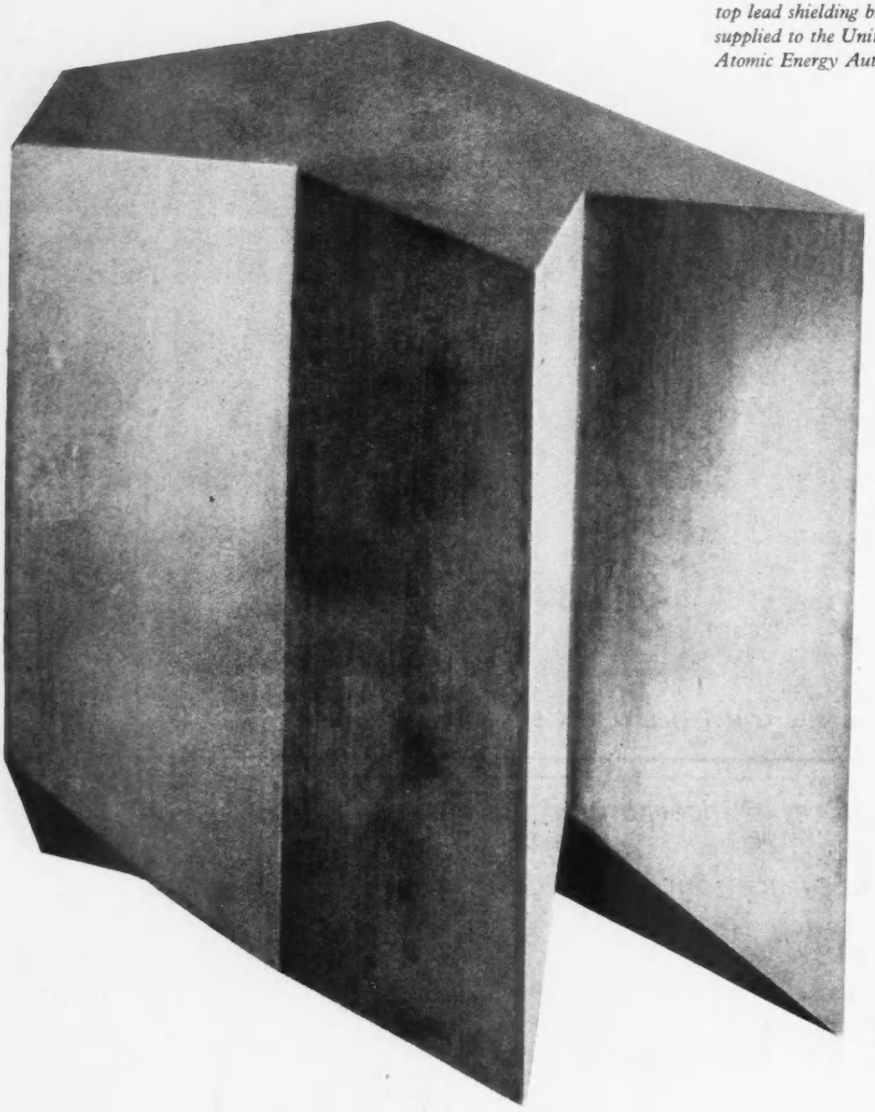
- *Maximum swing 20in., 11¾in. over cross slide.*
- *Diameter of hole through spindle 3¼in.*
- *15/5 h.p. motor.*
- *16 spindle speeds, 13 to 1,000 r.p.m.*
- *Power-operated Preoptive Headstock permits pre-selection of next speed whilst cutting*
- *Feed rates, 13 to 480 cuts per inch.*
- *12 reversible power feeds to saddle, cross slide and turret slide.*
- *Quick-power traverse to turret slide.*
- *Frictionless rotating turret.*
- *Chasing mechanism for cutting parallel or taper threads.*
- *All electrical switchgear built into machine, controls mounted on headstock.*
- *Leader control to turret slide, if required.*
- *Taper turning attachment, if required.*



ALFRED HERBERT LTD., COVENTRY

AD 431

Standard chevron-type corner top lead shielding brick as supplied to the United Kingdom Atomic Energy Authority.



Where lead is vital for shielding against radiation the people to consult are—

ASSOCIATED LEAD

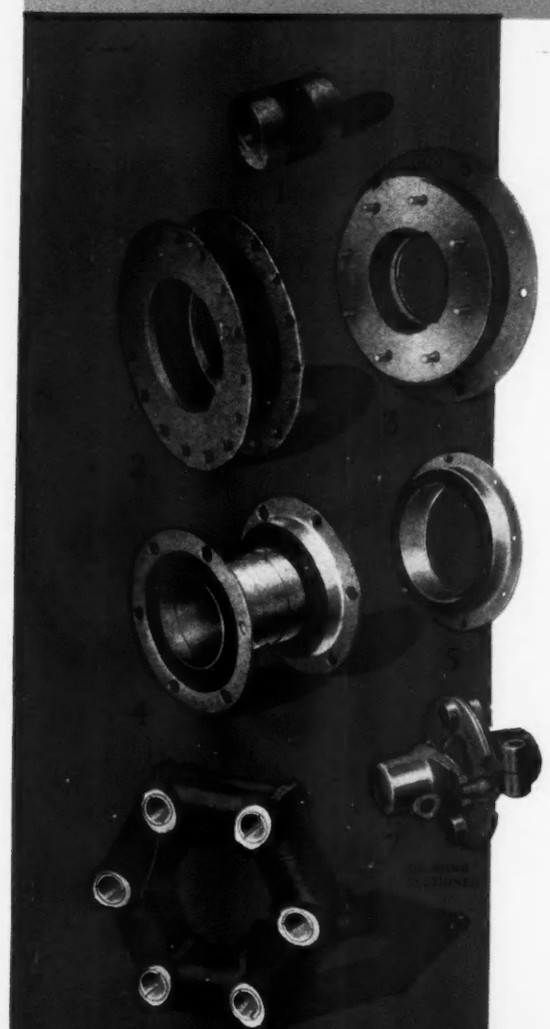
MANUFACTURERS LIMITED

Clements House, 14 Gresham Street, E.C.2.
Crescent House, Newcastle.
Lead Works Lane, Chester.

ASSOCIATED LEAD PRODUCTS

Export Enquiries to : ASSOCIATED LEAD MANUFACTURERS EXPORT CO. LTD., CLEMENTS HOUSE, 14 GRESHAM STREET, LONDON, E.C.2

The METALASTIK family of COUPLINGS



The controlled resilience of rubber, when applied to couplings, absorbs shock loads and torsional vibration, and permits misalignment. The Metalastik family of couplings has been designed to meet special requirements and meets nearly every need.

The illustrations show the following :—

1, 2 & 3. **METALASTIK VEE-TYPE COUPLINGS:** a most successful type of coupling transmitting torque through rubber loaded in shear. Will absorb shocks and damp out vibrations, possesses high torsional flexibility, and accommodates shaft misalignment. The metal parts of Fig. 1 type can be bored and keyed for fitting directly on the shafts.

4 & 5. **METALASTIK ULTRA-DUTY BUSH COUPLINGS :** especially suitable for high-speed operation. The design permits a high degree of torsional flexibility and provides for shock loads, vibration and conical misalignment of the shafts. For greater flexibility and a larger degree of misalignment, these couplings can be used in series with a light shaft connecting two couplings, as Fig. 4.

6. **METALASTIK "ROTOFLEX" COUPLINGS:** provide considerable torsional flexibility, accommodate angular misalignment and a large extent of end float; they are particularly suited for cardan shaft assemblies. For high-speed operation a special centring device is used.

7. **METALASTIK UNIVERSAL COUPLINGS:** have considerable torque capacity and little torsional flexibility but will accommodate angular misalignment with very low resistance.

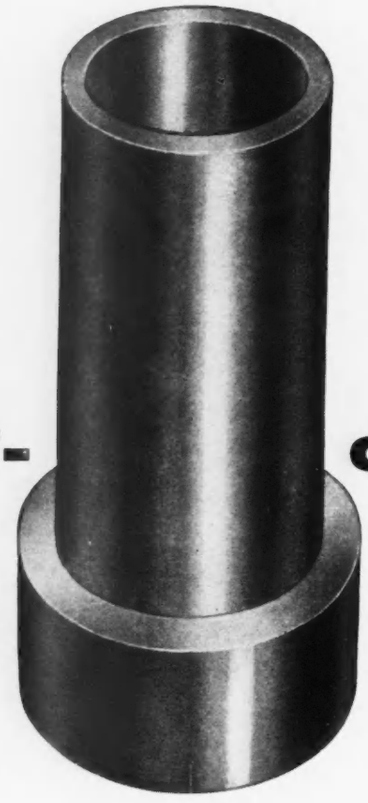
8. **METALASTIK DOUBLE-CONE COUPLINGS:** have a very high torque capacity and in other respects are similar to the Ultra-Duty bush coupling. End thrust can also be carried by these couplings and they are therefore particularly suitable for marine propulsion.

9. **METALASTIK TRAILING-LINK COUPLINGS:** accommodate considerable parallel misalignment as well as end-float and conical misalignment, and a single unit therefore replaces a long cardan shaft assembly.

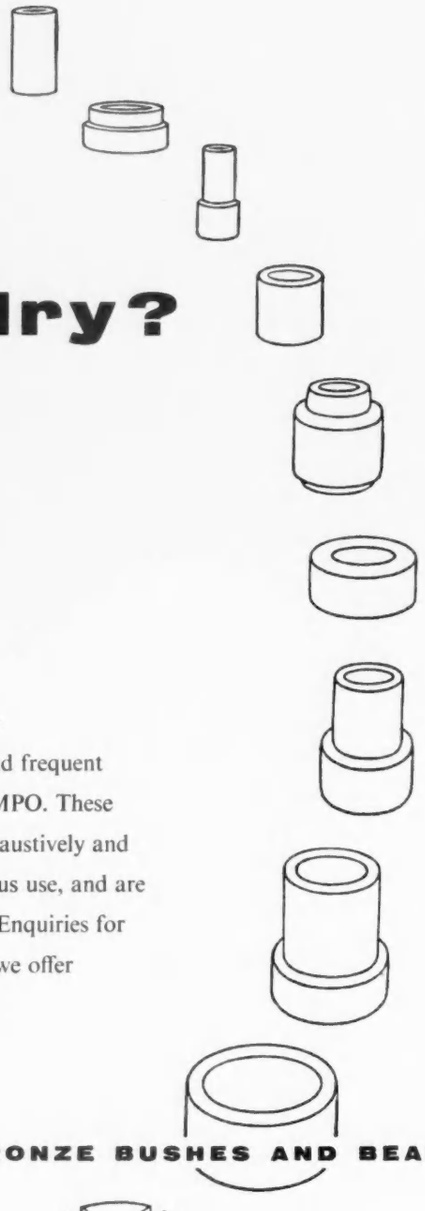
The experience of our engineers is at the disposal of all who are interested in flexible couplings and full information of proposed applications should be forwarded to our Technical Department.

METALASTIK LTD., LEICESTER

METALASTIK



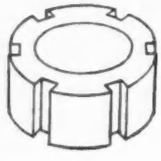
SWEET- or dry?

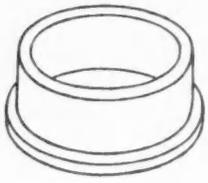


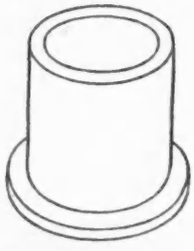
The choice of bearings—whether they will operate sweetly, or run dry, in locations where constant and frequent attention is impossible—has a ready answer: COMPO. These oil-retaining sintered metal bearings have been exhaustively and thoroughly proved reliable through years of arduous use, and are available in a comprehensive range of stock sizes. Enquiries for special COMPO bearings are also welcomed, and we offer consultative technical advice on matters of design.

COMPO

OIL-RETAINING BRONZE BUSHES AND BEARINGS



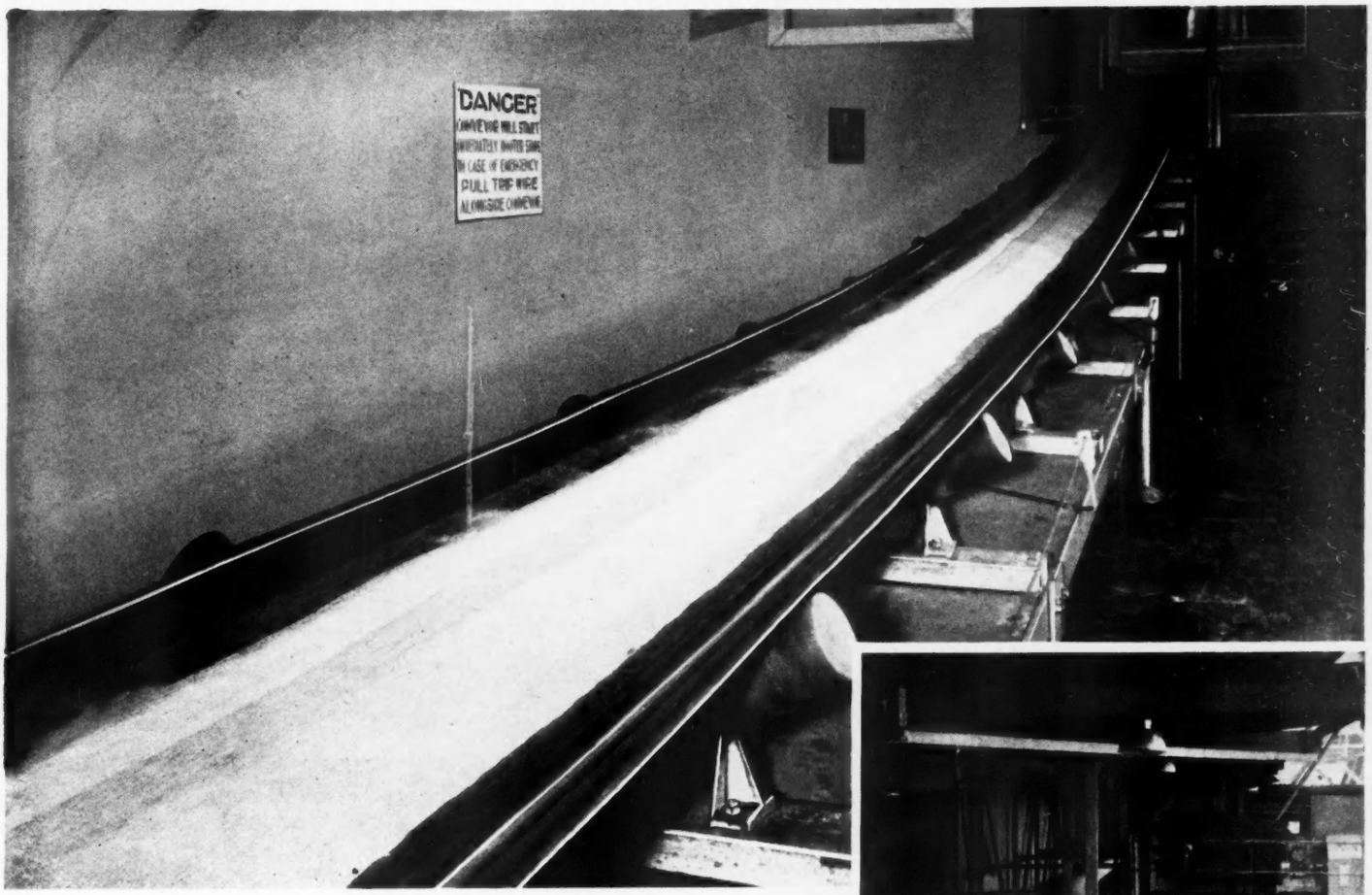


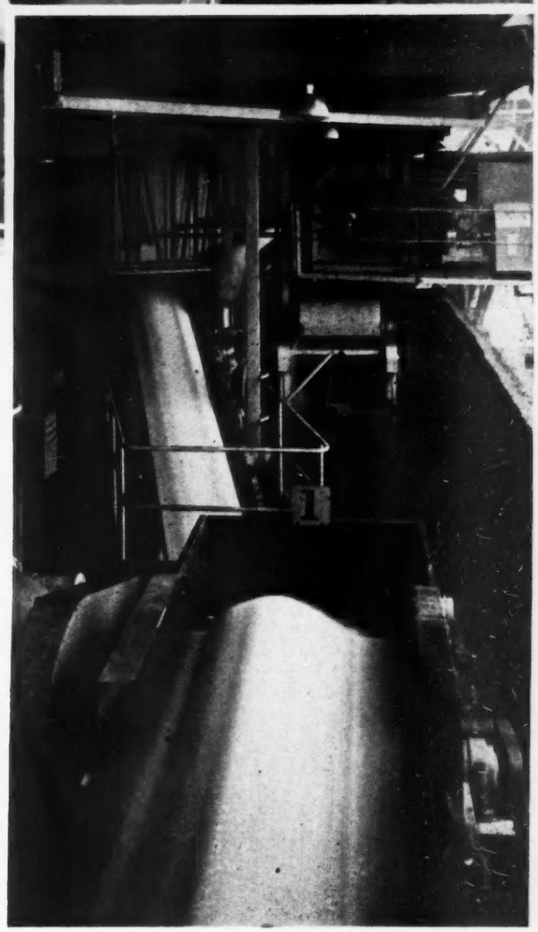


Bound Brook Bearings Limited

Trent Valley Road, Lichfield, Staffs.
Telephone: Lichfield 2027/8

MEMBER OF THE BIRFIELD GROUP





SPENCER HANDLING PLANT SPEEDS THE FLOW OF SUGAR

This subway conveyor handles raw sugar at the rate of 500 tons per hour.

The junction between the conveyors illustrated occurs in the quayside gantries at the 100,000-ton Tate & Lyle sugar storage silo at Huskisson Dock, Liverpool. The sugar is discharged from belt feeders attached to dockside cranes and conveyed on these 42" troughed belts at varying capacities up to 500 tons per hour.

Photographs by permission of Tate & Lyle Ltd.

SPENCER (MELKSHAM) LIMITED
MELKSHAM · WILTSHIRE

Branch Offices:

Ingersoll House, Kingsway, London, W.C.2. Tel. : Covent Garden 1800
34, Castle Street, Liverpool 2. Tel. : Central 3738

SPENCER

HANDLING PLANT

The jib for the job!

MORRIS

DIESEL-ELECTRIC

MOBILE CRANES

have the reach required!

Whether you want to lift up to 60 feet or up to a mere 15 feet, Morris mobile cranes can be supplied to provide the " reach " required, since the Morris range includes both the length and type of jib for most jobs.

Basically, the essential features of the crane chassis and superstructure remain the same irrespective of the length of the jib or whether it is of the strut type (as illustrated) or the cantilever type.

These features may be summarized as follows :—

Centrally mounted superstructure giving an equal radius clearance and stability when handling loads over the front or back of the crane.

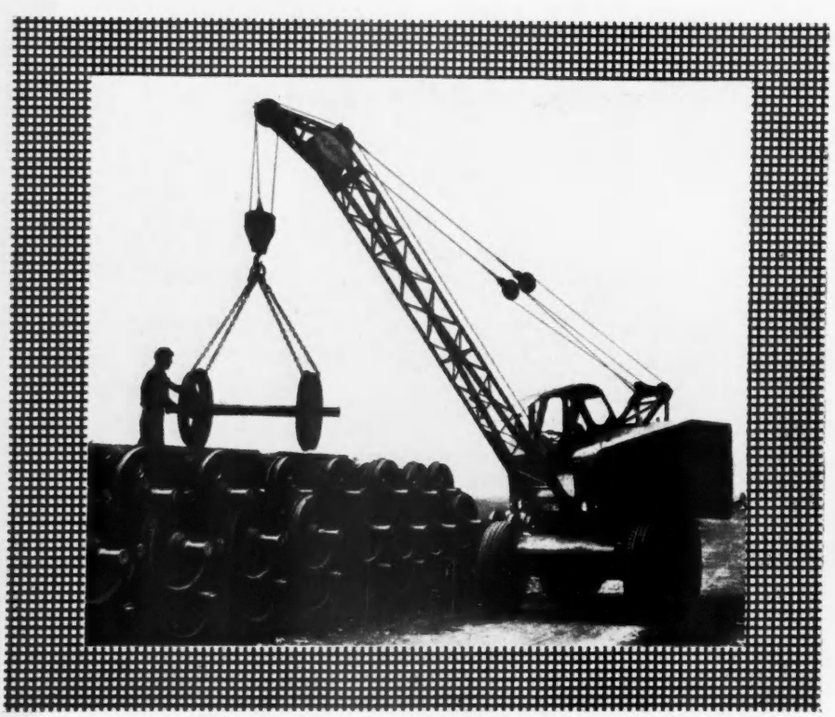
Easy control with no heavy levers to operate—just a finger touch controls all motions.

Flange mounted motors ensuring perfect and permanent alignment. All main assemblies are of unit construction.

Four-speed gearbox allows fast or slow travel according to the load being handled.

Hydro-mechanical brakes on all road wheels.

Fully interchangeable wheels, including tyres, rims, brakes and hubs. These components are interchangeable on all four road wheels of equal size.



By Courtesy of CAMBRIAN WAGGON & ENG. Co Ltd. CARDIFF

HERBERT MORRIS LTD P.O. Box 7 LOUGHBOROUGH ENGLAND

TELEPHONE : LOUGHBOROUGH 3123

It's all a Fabrication!

ON the plain in front of Troy its enemies toiled mightily on the towering fabric of that horse-shaped troop carrier which was to encompass the city's utter destruction and bring to an end the long Trojan War . . . .

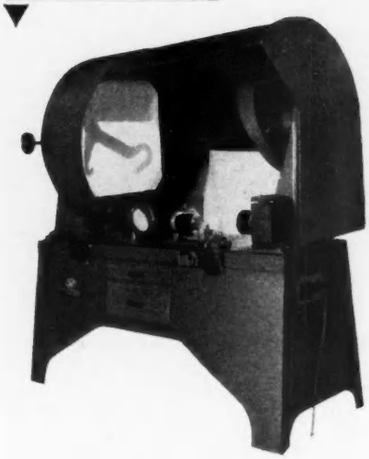
Fabrications to us at Craufurds, however, mean Construction—building for the future with strength and dependability, using good materials and fine workmanship.

Large or small your fabrication problems can be our concern.

Stainless Steel Vessels; part of test rig for Jet Fuel Filters at the Laboratories of British Filters, Ltd.

2 Ton Furnace Cupola Charging Bucket in ⅜" thick mild steel.

Structure and covers on a Work Projector by Optical Measuring Tools Ltd.



For Fabrications in all shapes and sizes consult :

CRAUFURD FABRICATIONS LTD.

DENMARK STREET, MAIDENHEAD, BERKS.

Telephones: 2585 PBX

OPERATION **TRANSPORT**

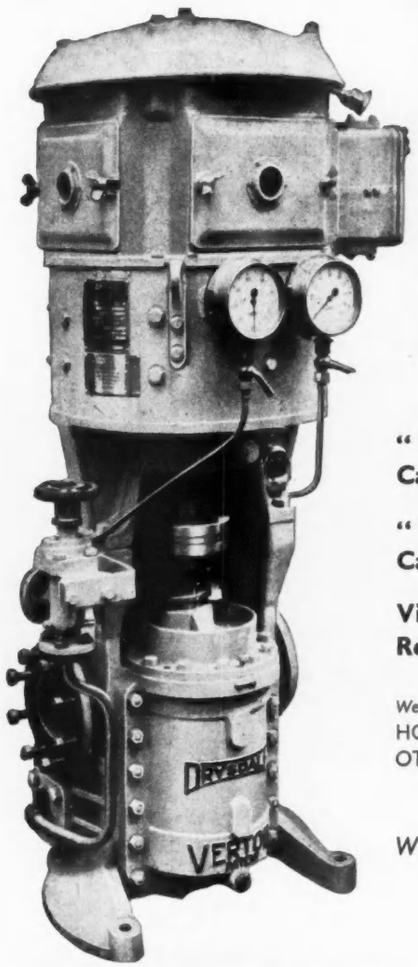
When John Thompson specialists take over a case, they first diagnose the amount of stress and shock the subject will have to undergo. That is the first stage in the manufacture of a John Thompson motor pressing, and is a vital factor in the production of pressings with a high strength-to-weight ratio. The actual operation is performed with the highest degree of skill, and in every instance the result is a motor pressing that is guaranteed a long and healthy life.

JOHN THOMPSON

MOTOR PRESSINGS

LIMITED

JOHN THOMPSON MOTOR PRESSINGS LTD WOLVERHAMPTON



DRYSDALE

"Vertoil" and "Horzoil"

(PATENT PUMPS)

These pumps are of the positive displacement rotary gear-wheel type. The "Vertoil" is a marine pump, designed for such duties as forced lubrication, oil fuel service, oil fuel supply, diesel and boiler oil transfer, etc.

The "Horzoil" is a horizontal pump suitable for land duties such as chemical and edible oil processes and marine duties such as lubrication oil transfer, boiler oil transfer, oil fuel service, oil fuel pressure supply, etc.

"Horzoil" sizes 1½" to 8"
Capacities up to 195 T.P.H.

"Vertoil" sizes 2½" to 11"
Capacities up to 298 T.P.H.

Viscosities up to 10,000 sec. Redwood No. 1.

We also make pumps for:
HOT OIL, PETROL AND OTHER REFINING DUTIES

Write for Leaflets 250 & 255

DRYSDALE & CO. LTD., YOKER, GLASGOW

DOWPACs a punch!

1 The DOWPAC LIQUID SPRING gives 3,900 lbs. at a deflection of 1".

2 ONE DOWPAC replaces EIGHT conventional springs.

Overall dimensions 4¾"x1¾" dia. provides concentrated power and occupies but a fraction of the space taken up by conventional springs. The power of the DOWPAC is the answer to all stripping or spring problems.

DELIVERY:—EX STOCK. Other sizes in course of production. (Patent applied for.)

For further details, write or telephone:—**SOLE DISTRIBUTORS**

A DOWTY PRODUCT

REDMAN TOOLS & PRODUCTS LTD.

BOX No. ENG. 40, GREGORY'S BANK, WORCESTER, ENGLAND

Telephone: Worcester 6397 (3 lines). *Telegrams:* Redtools, Worcester.

THERMAL ELEMENTS.

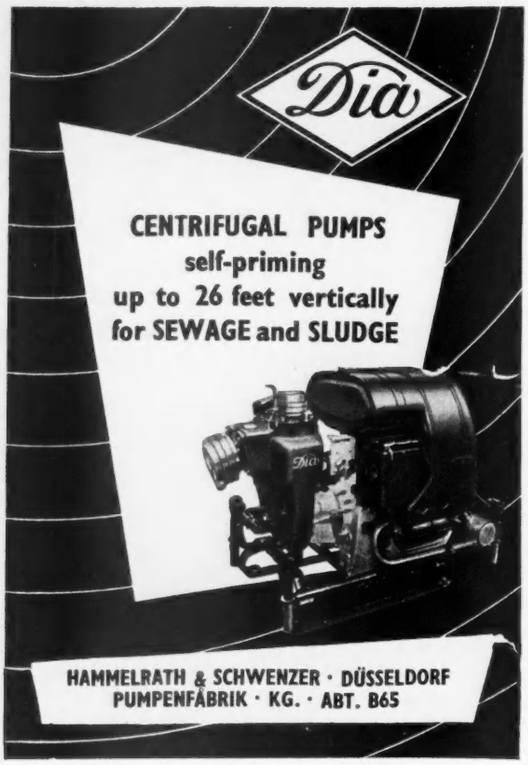
Invite your enquiries for :—

ELECTRIC ELEMENTS

- INDUSTRIAL TUBE HEATERS
- FRAME HEATERS
- CERAMIC ROD HEATERS
- RESISTANCES
- CERAMICS

RING - UPLANDS 5285.

STATION WORKS
WHYTELEAFE - SURREY.



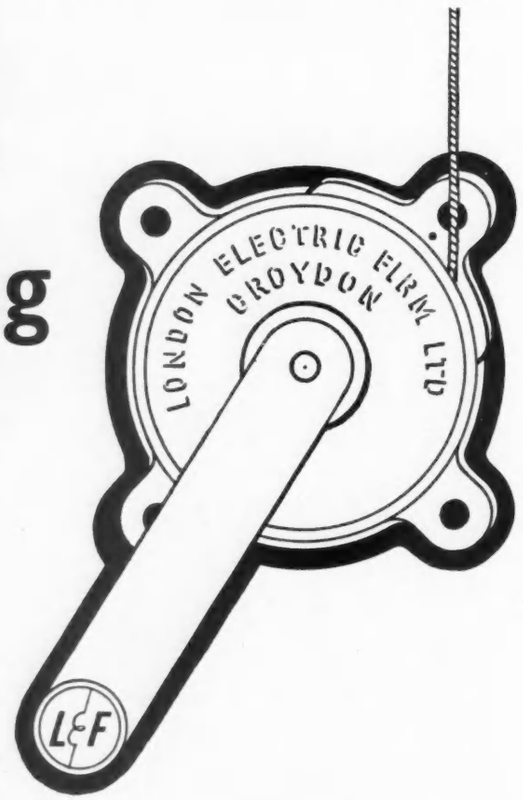
HALF A MILLION
now in use!

L.E.F. self-sustaining
HAND WINCHES

No worm or gear wheels
No ratchets, pawls or springs
No levers or other small parts

The simplicity of the L.E.F. self-sustaining winch has created a great demand and is made in several sizes.

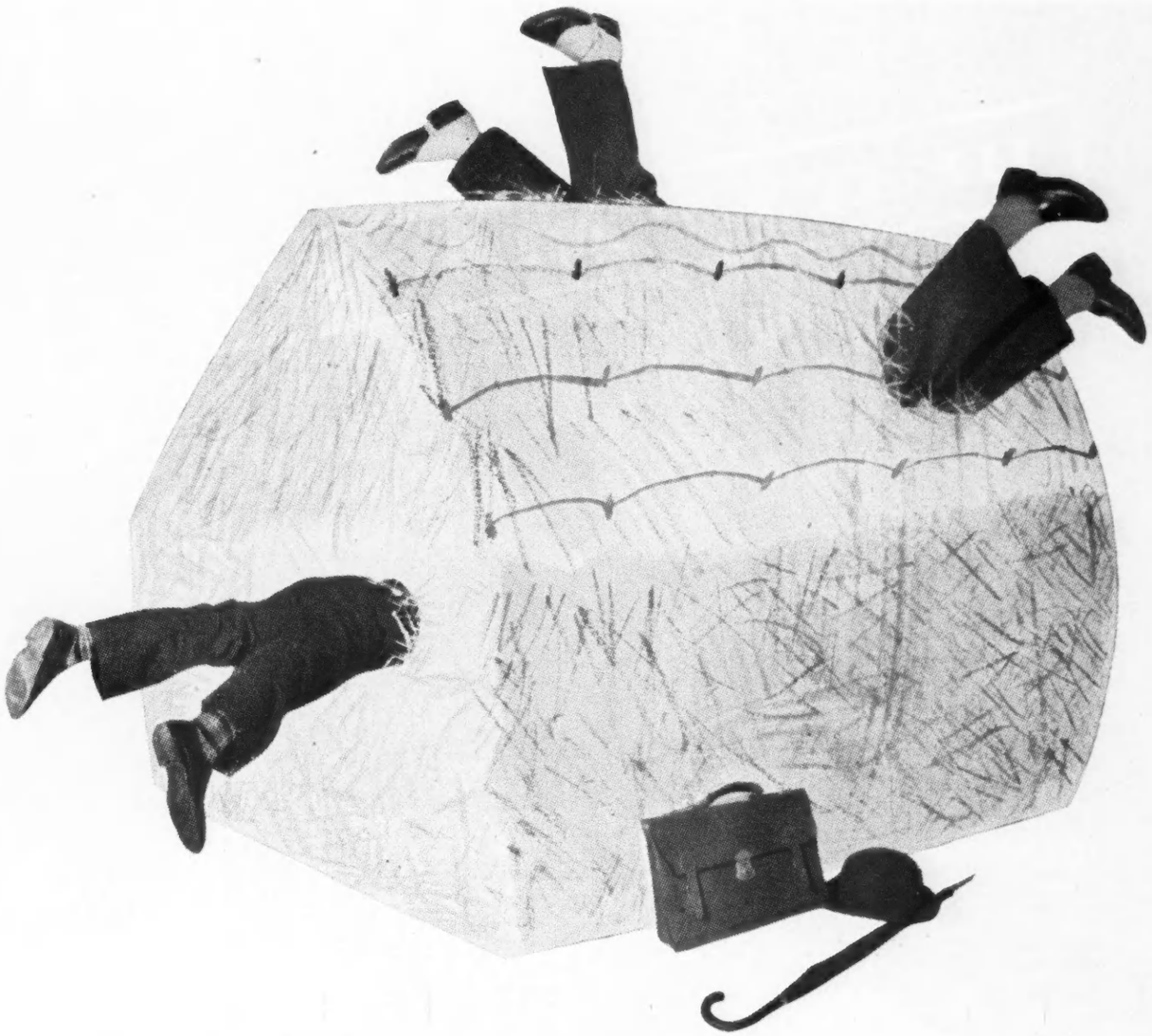
Special hand or electric winches can be designed to suit your purposes. Write today for catalogue and information.



LONDON ELECTRIC FIRM LIMITED *Brighton Road, South Croydon, Surrey*

Telephone: Uplands 4871 **Telegrams: Electric Phone Croydon**

TIB 118



Looking for something?

The SARAH radio rescue beacon was designed to locate and rescue the survivors from crashed aircraft, and has solved many other difficult search and location problems.

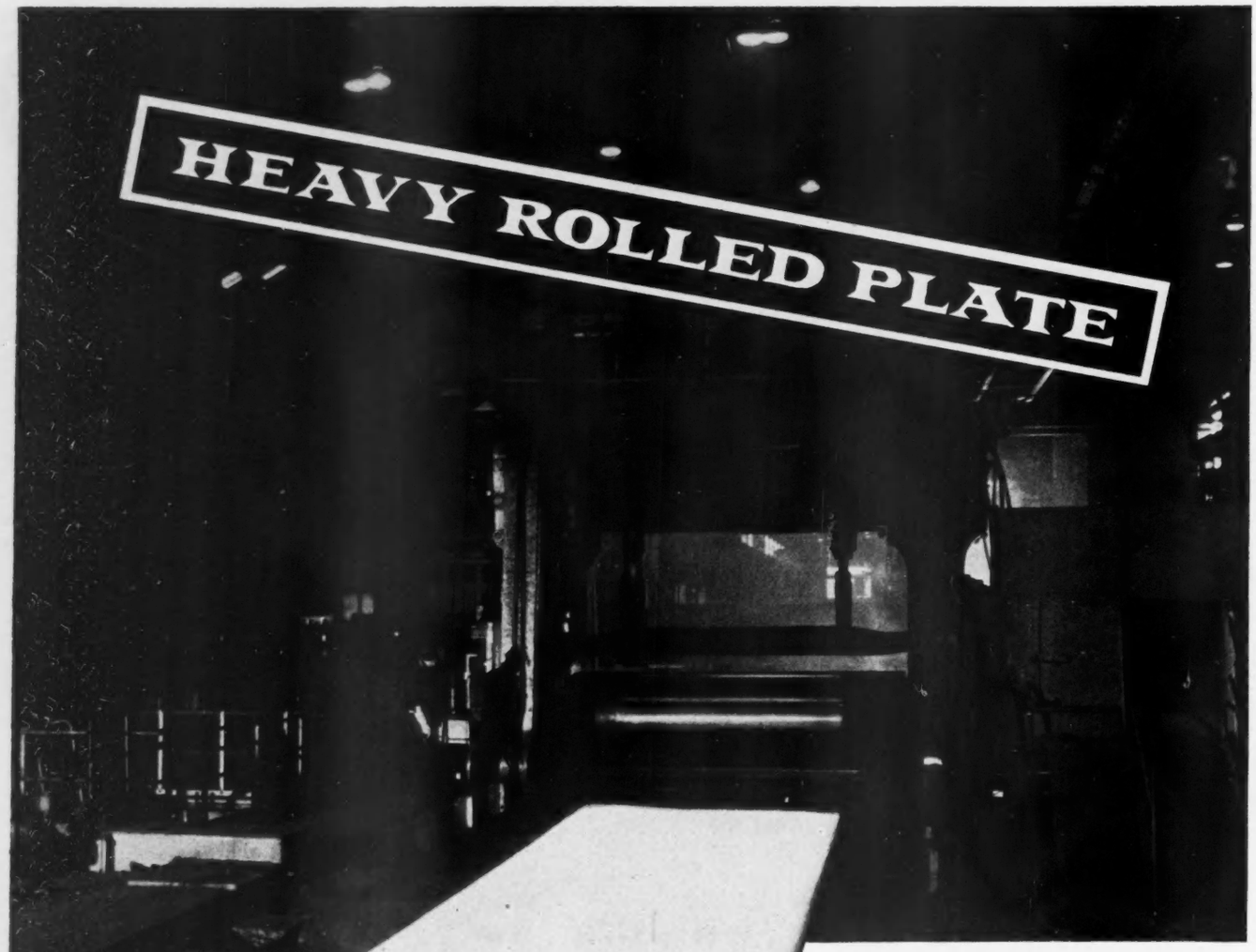
Ultra Electric is serving many industries in many ways, applying to their needs all the skill, experience and ingenuity that created Aircraft Jet Pipe Temperature Control Equipment, directional Sonobuoy transmitters, and the new Radar Simulator Systems

ULTRA ELECTRIC LIMITED

SPECIAL PRODUCTS DIVISION

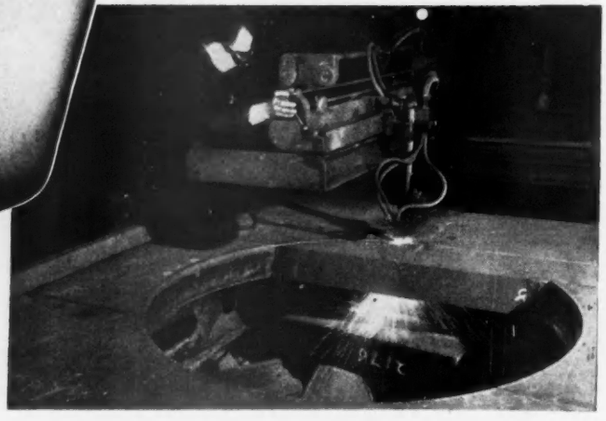
WESTERN AVENUE, LONDON, W.3. Telephone: ACOrn 3434

AIRCRAFT CONTROLS & RADIO EQUIPMENT • RADAR SIMULATORS
COMPUTER EQUIPMENT • AIR SEA RESCUE BEACONS • ELECTRIC SERVO SYSTEMS



Rolling heavy steel plate in 48″ Mill.

Profile cutting to templates.



for Nuclear Power Installations Industrial Plant Assemblies and General Engineering

Recent reconstruction of our Heavy Plate Mill now enables us to accept additional orders for plates from $1\frac{3}{4}$″ to 16″ thickness. All plates are hydraulically flattened to close limits.

ESC

ENGLISH STEEL FORGE AND ENGINEERING CORPORATION
Limited

River Don Works, Sheffield

A wholly owned subsidiary of English Steel Corporation Ltd.

KONTITE

The World's Finest Pipe Fittings

- All Kontite Castings are made in corrosion resisting gunmetal.
- The Kontite range of fittings is the largest in the trade.
- Our delivery service is second to none and all items can be delivered within a matter of days.
- Kontite Compression Fittings are made for all sizes of pipe up to 6" bore.

Free comprehensive catalogue will be supplied on request.

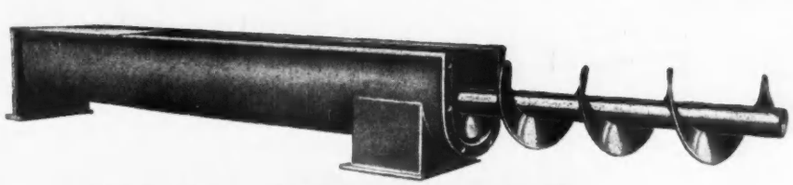
KAY & COMPANY (Engineers) LTD.

ENGINEERS BRASSFOUNDERS & ALLOYERS

Bolton Brass Works, Blackhorse Street, Bolton, Lancs.

Phone: 3041 · Grams: "Kontite" Bolton · Telex No. 63-186

HOWEVER SPECIAL YOUR REQUIREMENTS MAY BE ——— WE CAN SUPPLY FITTINGS FOR YOUR PURPOSE



SCREW CONVEYOR

EMINENTLY SUITED FOR CONVEYING BULK MATERIAL

STANDARD INTERCHANGEABLE PARTS

50 cu. ft. hour to **4,500** cu. ft. hour Capacities

W. S. BARRON & SON LTD.

GLOUCESTER

Manufacturers with over 50 Years' experience—Offer the latest in

CRUSHING · GRINDING · MIXING

FEEDING · SIEVING

MACHINERY

The most practical way of Elevating bulk material

COMPACT · ECONOMICAL

TROUBLE-FREE

•

1 to 50 tons per hour Capacities

Screw-Lift

PATENTED AND TRADE MARK REG. U.S. PAT. OFF.

Phone: Gloucester 21055-6-7

B T-H

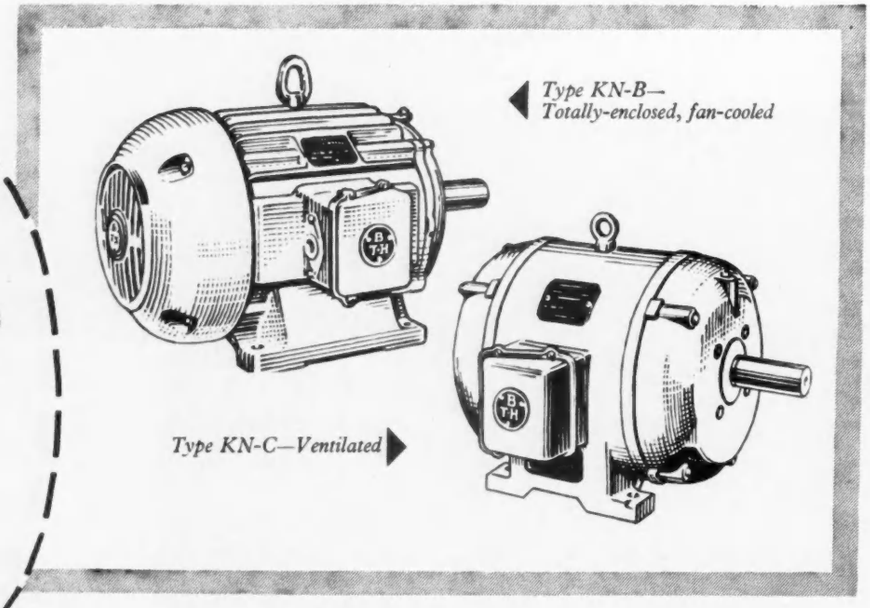
please to remember

the First of November

IMPORTANT PRICE REDUCTION

for

BTH British Standard Dimension Motors



Type KN-B—
Totally-enclosed, fan-cooled

Type KN-C—Ventilated

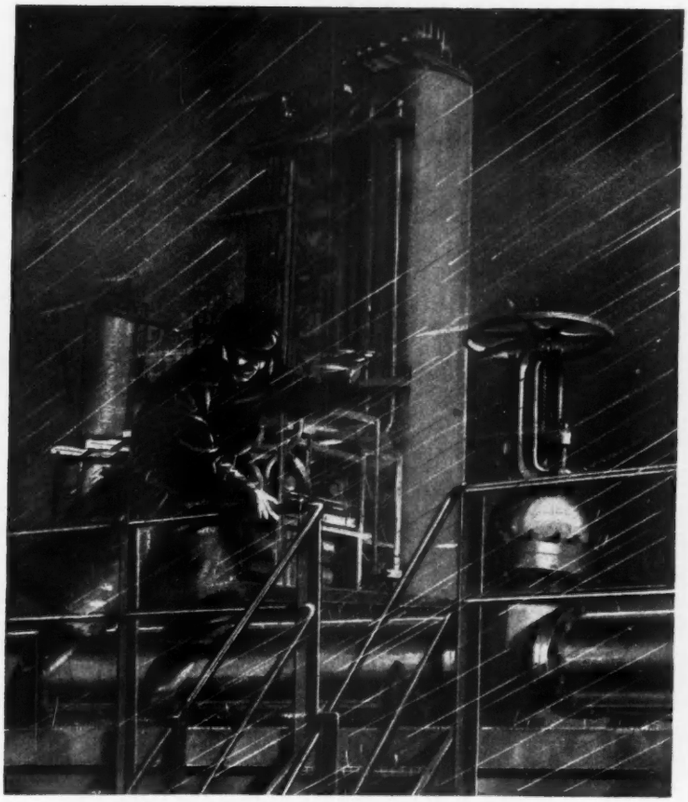
Take advantage
of the price reduction—
effective from 1st November, 1958
—for these high quality motors.
Most sizes are available
from stock. Further details
are given in Publication G13032.
Please write for
your copy.

BRITISH THOMSON-HOUSTON

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND

an A.E.I. Company

A5336

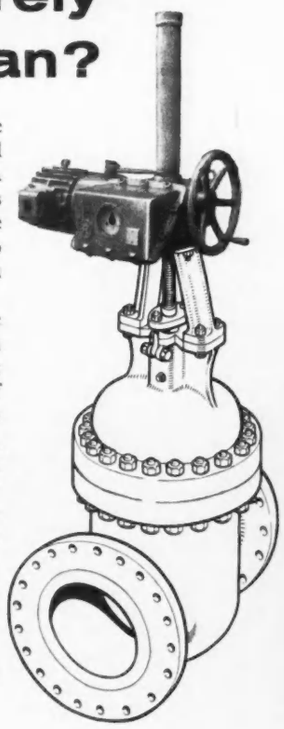


Dare you rely on this man?

In numerous valve installations all over the world the successful operation of plant still depends too much on the individual. A responsible, arduous task when the sun is shining becomes a dangerous, formidable assignment in filthy weather. Dangerous to the operator, and dangerous to the plant in which he is the weak link.

Whatever the weather, irrespective of site conditions and regardless of the service on which they are employed, there are Rotork actuators to operate all sizes and types of valves. Rotork electric actuators can be operated by push-button from any distance, or automatically from any set of data such as time, level, temperature, pressure etc. They thus make possible a reliable all-electric control system for valves, and enable plant to function automatically.

Our catalogue contains much useful information about valve control. May we send you a copy?



A Rotork 100AS Actuator fitted to a 16" class 600 valve.

Rotork Actuators for Valve Control

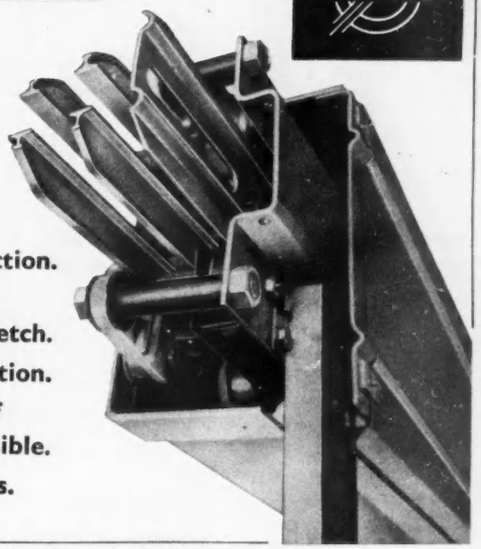
ROTORK ENGINEERING CO. LTD., of BATH, ENGLAND Tel: 64558

OBERTRAK? *for Safety?*

YES, because OBERTRAK CONTACT RAILS are totally enclosed . .

OBERTRAK

Send for descriptive literature



- ★ Sturdy construction.
- ★ No wires to stretch.
- ★ Simple installation.
- ★ Any number of poles possible.
- ★ No breakdowns.

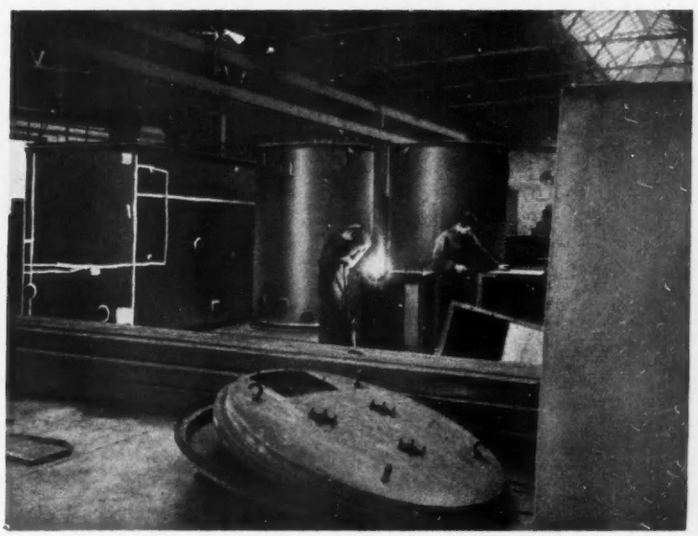
J. H. OBERMAN & SONS LTD. HIGHAM FERRERS NORTHANTS

Telephone : RUSHDEN 2162/2844

FABRICATIONS IN STEEL

INDUSTRIAL TANKS, ROOF & UNDERFRAME TANKS FOR RAILWAY COACHES, DIESEL ENGINE TANKS, PRESSED STEEL GUTTERS, LIGHT CONSTRUCTIONAL STEELWORK

SPECIALISTS IN* HOT DIP *GALVANIZING



JOSEPH ASH & SON LTD.

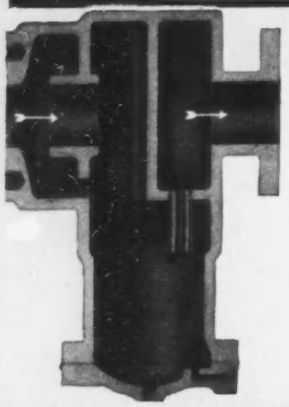
ESTABLISHED 1845

REA STREET SOUTH, BIRMINGHAM 5. *Tel: MIDland 2441*

LONDON OFFICE: 225 WESTMINSTER ROAD, LONDON, S.E.1. *Tel: WATerloo 4682*

"The Lancaster"

IMPACT SEPARATOR

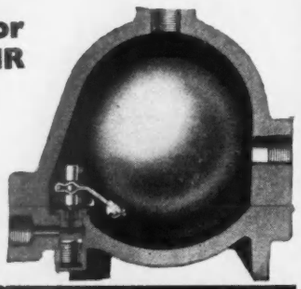


FOR SEPARATING OIL or WATER from COMPRESSED AIR or STEAM.

Large numbers are in use in Colliery Air Mains, Compressor Intercoolers, Spray Painting Plants, and many other Installations where dry air is essential.

CAN BE SUPPLIED COMBINED WITH TRAP or SEPARATE AIR TRAP.

SPHERICAL FLOAT TRAP for STEAM or COMPRESSED AIR



"The Lancaster" Air Trap consists of a sealed float which rises and opens a discharge valve when the water collects in the trap. It presents a DEAD seal against leakage of air when draining water from Compressed Air Apparatus. Two alternative Inlets are provided, vertical or horizontal. Will lift the discharge water. Supplied in ¼in., ⅜in. and 1¼in. sizes.

Manufacturers of "The Lancaster" Steam Traps for all purposes.

Send us your enquiries—over 70 years' experience is at your disposal.

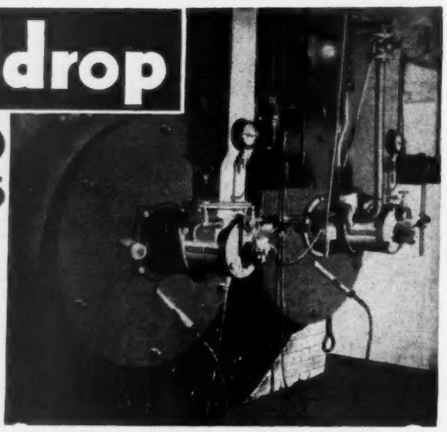
LANCASTER & TONGE LIMITED

PENDLETON · MANCHESTER · ENGLAND

TELEPHONE PENDLETON 1484/5/6 TELEGRAMS "PISTONS MANCHESTER"

Schieldrop

OIL FIRED BOILERS



We Guarantee

13½ to 14 per cent CO_2 with Shell Smoke number 4 or less.

Schieldrop & CO. LTD

STOTFOLD, BEDS. Tel. 414 (3 lines) **OFFICES AT : BIRMINGHAM · LONDON · MANCHESTER SWANSEA · GLASGOW.**

BM1

Britain's Best Anti Vibrator Lamp Fitting

● **SAVES THE FILAMENT** ● **REDUCES MAINTENANCE COSTS**

MORE ENGINEERING WORKS, FACTORIES are fitting **PROTECTAFIL** SHOCK ABSORBERS to all their lighting points Dispersive and Fluorescent. **VIBRATION** causes a large number of lamps in industrial installations to fail prematurely. You will find an easy solution in the use of **PROTECTAFIL** Approved by the Arts Council of Industrial Design, Central Electricity Authority, Australian Electricity Approval Board.

Write for illustrated Catalogue T.E. and a sample PROTECTAFIL *Anti Vibrator Shock Absorber.*

J. E. WILDBORE LTD. PETER ST., OLDHAM. MAI 4475

WOVEN WIRE

F. W. POTTER & SOAR LTD.

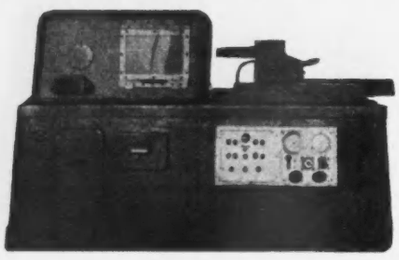
Made in **ALL METALS.**
Our range of Weaving covers all grades from the **FINEST WIRE CLOTH** to the **HEAVIEST SCREENING.**
A.I.D. and **A.R.B.** approved

Please write for our Brochure, containing useful Technical information.

PHIPP STREET LONDON E.C.2

Cadamco

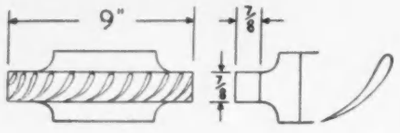
SOLID ROTOR AEROFOIL MILLING MACHINE



Cadamco announce the marketing of a new machine for milling blade forms on solid rotor discs.

Fully automatic cycle. Universal application by changing fixture, cam and index plate. Component material either aluminium or steel alloy.

Exclusive manufacturing and selling rights under licence from the Bristol Aero Engine Company, Limited.



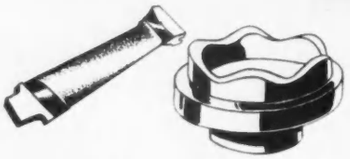
Example : The floor-to-floor time for a component of 9" diameter in Aluminium Alloy with 32 blades cut to a depth of ⅞" is 96 minutes.

COPY BELT-GRINDING MACHINE

A new and unique machine for removing metal from irregular forms such as turbine and compressor blades and giving a ground finish.

A machine of low capital and tooling costs, the Cadamco Copy Belt-Grinder is capable of working in a wide range of materials from Nimonic 100 to Aluminium.

One side of the component is ground at each operation, and discrepancies from form in forgings or pre-machined components are corrected in grinding.



Exclusive manufacturers in Great Britain under special licence from:— ARMSTRONG SIDDELEY MOTORS LTD., Coventry, (British Patents No. 38968/57, International Patents applied for).

CYRIL ADAMS & CO. LTD.. 155 East Barnet Road, New Barnet, Herts. *Tel:* BARNET 2335-6-7

Designers and Manufacturers of Jigs, Fixtures and Special Purpose Machine Tools

SOLE SELLING AGENTS for Great Britain for OLIVETTI, Turin; OERLIKON, Milan; SOC. CAMUT, Turin; MARIANI, Milan; MINGANTI, Milan; CIMAT, Turin; GALDABINI, Gallarate, Turin

The World uses Araldite

Belgium

Accumulator case for aircraft, made from "Araldite" Casting Resin B.
Manufacturer: Ateliers Mecaniques de Precision S.A., Brussels.

CIBA

"Araldite" is a registered trade name

Araldite Casting Resins
Araldite Coating Resins
Araldite Laminating Resins
Araldite Adhesives

CIBA (A.R.L.) LIMITED

Duxford, Cambridge. Telephone: Sawston 2121

attention to detail

Skill, experience and attention to detail during the design and manufacturing stages of HWP/Fluor Counterflo Cooling Towers, ensure that cooling can be guaranteed between prescribed limits, and that the Towers will function with the utmost efficiency and minimum attention for long periods.

FAN ASSEMBLY—A high efficiency, low speed, axial type, cooling tower air prime mover.

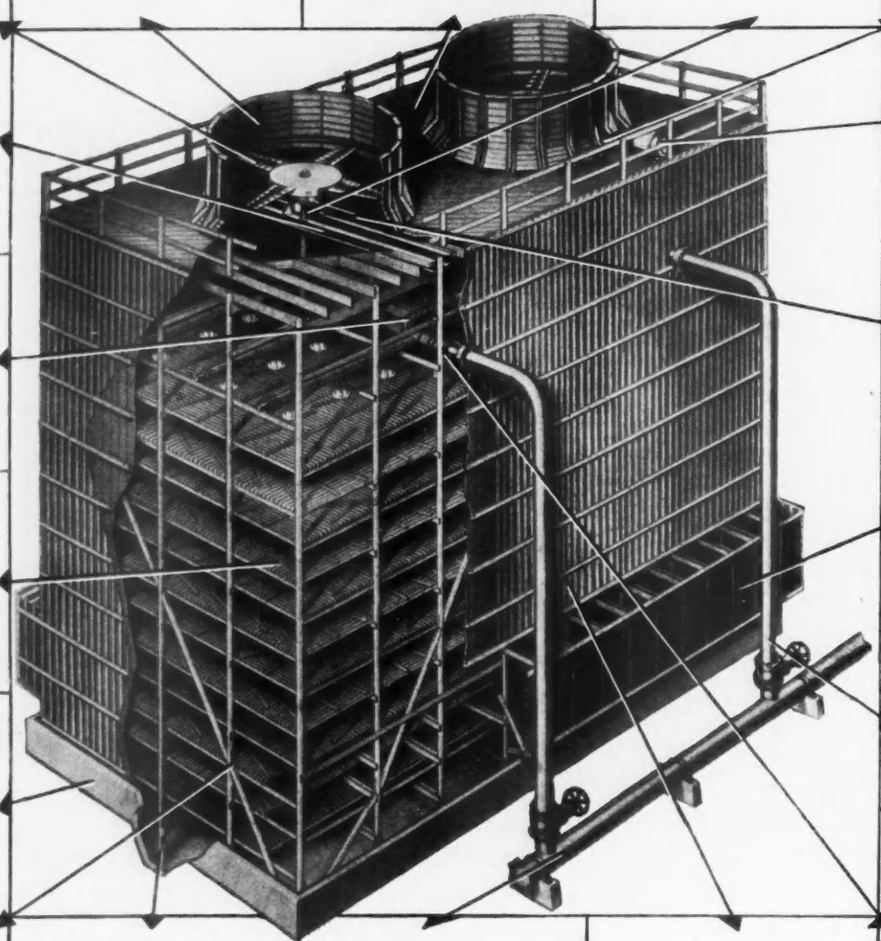
FAN STACK—Specially designed for trouble-free, vibrationless operation. Fabricated of seasoned redwood. Internal annular ring ensures maximum exhaust velocities.

FAN DECK—Diagonal decking, blocking and stress strips form a structural diaphragm which distributes live loads—wind, vibration—uniformly to all bracing.

SPEED REDUCER—A device for reducing fan driver speed to fan operating speed. May be single or double reduction gear or hydraulic motor.

VIBRATION CUT-OUT SWITCH—In case of excessive vibration of mechanical assembly, automatically shuts down fan driver.

SUPPORT FOR DRIVER AND SPEED REDUCER—Structural unit support for driver and speed reducer.



FAN DRIVER—A prime mover for fan service that may be an electric motor, gas turbine, steam turbine, or hydraulic motor.

DRIFT ELIMINATORS—A multi-pass baffle section constructed to minimize the entrained water in exit air stream.

DRIVE SHAFT—Floating shaft and flexible coupling assembly for transmitting power from driver to gearbox.

TOWER FILLING—Grid Decks or filling to provide maximum and continuous water break-up with a minimum of obstruction to flow of cooling air.

LOUVRES—Set three feet out from side, yet require no greater basin dimensions. Air is drawn into tower with less pressure drop. Icing problem formerly associated with louvres adjacent to tower columns eliminated.

BASIN—This collects the tower water and provides structural support for tower.

RISER—That vertical connector pipe between the manifold and cooling tower header.

WATER DISTRIBUTION SYSTEM—Completely non-corrosive . . . header and laterals of redwood stave construction banded with stainless steel . . . nozzles of porcelain (and stainless steel) or plastic. Headers and laterals are provided with cleanout valves and plugs for flushing during tower operation.

STRUCTURAL FRAMING—Redwood columns, braces, and chords, through bolted, utilizing connector plates.

BASE CASTING—A cast footing provided to ensure a uniform and solid connection between the tower columns and the basin pads.

MANIFOLD HEADER—A hot water pipe manifold distributing water to individual risers and cells.

SHEATHING—A tower sheathing designed for architectural beauty and positive elimination of leaks.

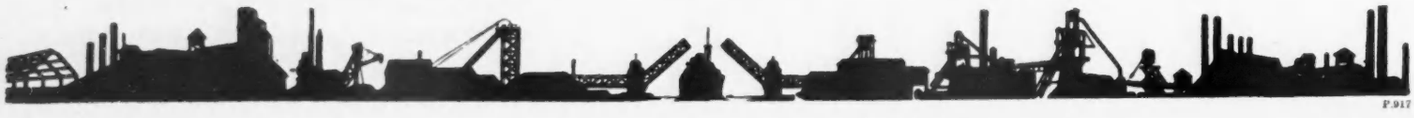
Head Wrightson Processes design, manufacture and erect prefabricated timber and precast concrete Induced Draught Cooling Towers for all purposes. It will pay you to consult them on your own cooling problems.

HEAD WRIGHTSON PROCESSES LTD

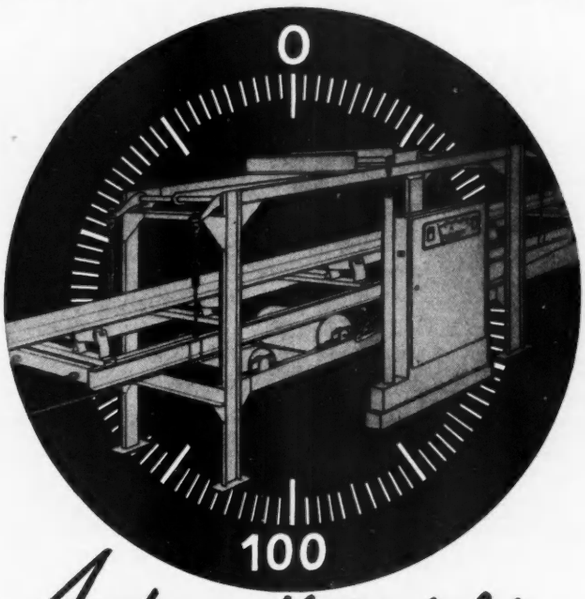
TEESDALE HOUSE · 16/26 BALTIC STREET · LONDON · EC1

OFFICES AT: P.O. Box 1595 **SYDNEY** · P.O. Box 1034 **JOHANNESBURG** · P.O. Box 2608 **CALCUTTA** and P.O. Box 706 **HAMBURG**

Associates in the U.S.A.: The Fluor Products Company · Los Angeles · New York · Chicago · Tulsa etc.



P.917

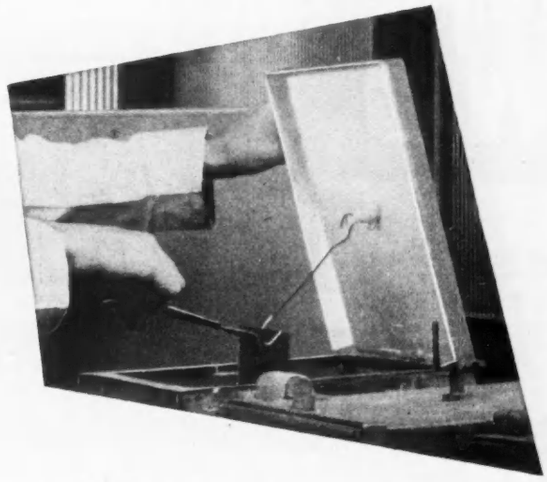


Automatic weighing and conveying

by Automatic Weighing-Machines with electrical load recording. Railway Truck Weighbridges, Road Truck Weighbridges, special designs for industrial requirements and many other types of weighbridges

DÜSSELDORFER WAAGEN- U. MASCHINENFABRIK
ED. SCHMITT & CIE. G.M.B.H.
DÜSSELDORF-GERMANY-P.O.B. 11127

Are these hands helping *you?*



These hands are but a pair among many engaged in the continuous testing and experimental work carried out in P.J. laboratories, where skilled paint technicians tackle the complex problems which confront industrial paint users. Your area P.J. technical representative will bring you the services of this team of experts to advise and assist you with your finishing problems.

You can rely on
PINCHIN JOHNSON
for Paint and Service

PINCHIN, JOHNSON & CO., 4 CARLTON GARDENS, S.W.1
Telephone: TRAfalgar 5600

BELFAST • BIRMINGHAM • BOOTLE • BRIGHTON • BRISTOL • GLASGOW
LEEDS • MANCHESTER • NEWCASTLE-ON-TYNE • SOUTHAMPTON

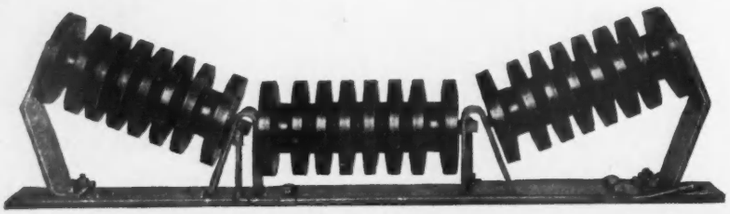
GK
GUEST KEEN IRON & STEEL COMPANY

For... **FERROUS AND NON-FERROUS**
CASTINGS
FOR ALL INDUSTRIES

Made with the experience and skill gained by generations of craftsmen at the famous
DOWLAIS WORKS
Telephone: Dowlais 70
GUEST KEEN IRON & STEEL COMPANY LIMITED
HEAD OFFICE: EAST MOORS, CARDIFF. *Phone: Cardiff 33151*

WD

ELEVATING & CONVEYING MACHINERY

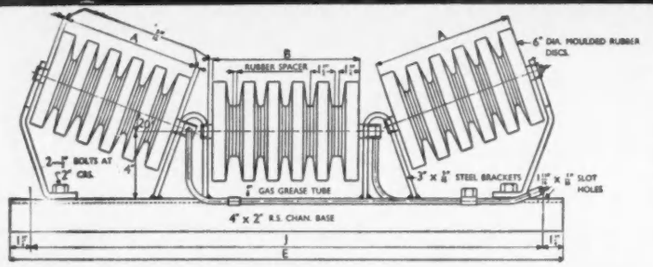


FULLER DETAILS OF IMPACT IDLERS AND OTHER TYPES OF IDLERS AVAILABLE ON REQUEST

Cut replacement costs

Conveyor belts are expensive items. It has been proved that Westwood Dawes Rubber Disc type Impact Resisting Troughing Idlers reduce wear caused by the impact of heavy or abrasive material. It will pay you to fit these resilient idlers at all points of strain and at all loading and transfer points where wear is constant and the going tough.

IMPACT IDLERS PROTECT YOUR CONVEYOR BELTING!



BELT	A	B	J	E
12" BELT	5"	5"	22"	19½"
14" "	5"	6"	24"	21½"
15" "	5"	7"	25"	22½"
16" "	5"	8"	26"	23½"
18" "	6½"	7"	28"	25½"
20" "	7"	8"	30"	27½"
22" "	7½"	9"	32"	29½"
24" "	8½"	9"	34"	31½"
26" "	9"	10"	36"	33½"
28" "	10"	10"	38"	35½"
30" "	10½"	10½"	40"	37½"
36" "	12½"	12½"	46"	43½"
42" "	15"	15"	52"	49½"
48" "	17"	17"	58"	55½"

We also manufacture:—
2, 3 and 5 Roll Standard Troughing Idlers. Flat and Return Belt Idlers. Rubber Disc type Return Idlers. Adjustable Take-Up Units for all duties. Mild Steel fabricated Conveyor Drums of any size AND COMPLETE CONVEYOR INSTALLATIONS.

WESTWOOD DAWES & CO. LTD., Bowling Green Road, Stourbridge, Worcs. Tel: 4741 (4 lines)

NON-FERROUS CASTINGS? SCC OFFER A COMPLETE Service

TO THE ENGINEERING INDUSTRY

One of the best equipped non-ferrous foundries in Europe, Sandwell offer you :—

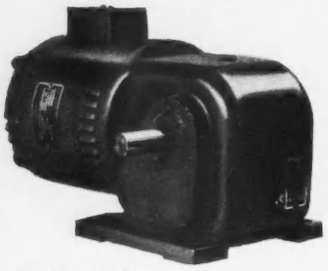
(1) MOST MODERN METHODS. Finest quality precision Sand Castings, Gravity Die-Castings, Shell Moulded Castings, and Pressure Die-Castings.
(2) WIDEST RANGE. Castings from a few ounces up to 2 tons in weight.
(3) COMPETITIVE PRICES.
(4) PROMPT DELIVERIES.
(5) FREE TECHNICAL ADVICE on all Castings problems.

For all your requirements in non-ferrous castings, LET SANDWELL QUOTE.

ILLUSTRATED LITERATURE ON REQUEST.

THE SANDWELL CASTING CO.
BANK STREET FOUNDRY, WEST BROMWICH.
Telephone: STOnecross 2231 (4 lines). Telegrams: "REPCAST", WEST BROMWICH.
One of the SANBRA Group of Companies

right-angled geared motors

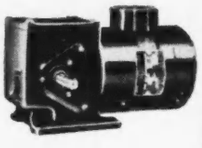


NECO right angle drive geared motors are units of compact design especially suitable for applications where space is limited. There is a wide range of output speeds and gearing is by worm, or worm and spur reduction, according to type of unit.

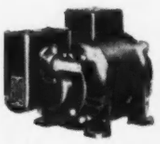
Patent applied for

NEW TYPE DR GEARED MOTOR

Type DR geared motors have ball bearing oil-immersed worm and wheel, with additional spur reductions. Motors of 1/6, 1/4, 1/3 or 1/2 h.p., for 3 phase, single phase or D.C. supplies, are fitted to the one-piece cast-iron gearbox. Final shaft speeds are from 15.6 r.p.m. to 305 r.p.m. Speeds down to 0.05 r.p.m. with a maximum torque of 100 lb.-ft. are available.



TYPE SW 1/8 h.p. motors 3 phase, single phase, or D.C final shaft speeds between 27 r.p.m. and 0.055 r.p.m. Maximum output torque is 25 lb ft. below 14.8 r.p.m.



TYPE W 1/8, 1/4 or 1/3 h.p 3 phase, single phase, or D.C Final shaft speeds from 2 r.p.m. down to 90 or 45 r.p.m according to output.

NECO TRADE MARK

geared motors

NECO GEARED MOTORS LTD
204 QUEENSTOWN ROAD · LONDON · S.W.8
Telephone: MACaulay 3211-4

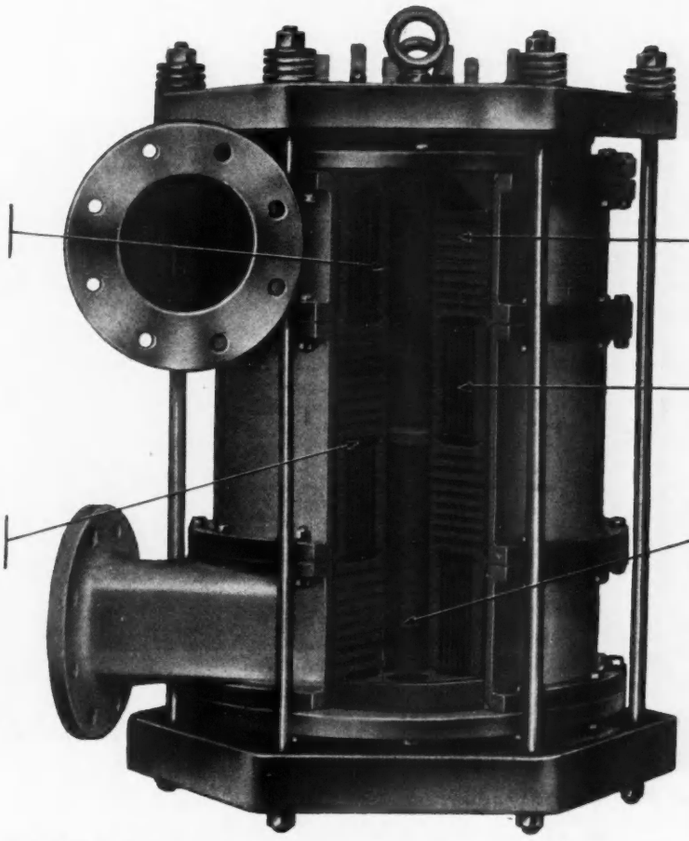
Subsidiary of Normand Electrical Company Limited

heating or cooling corrosive fluids?

POLYBLOC
TRADE MARK

acclaimed the most efficient...

GRAPHITE HEAT EXCHANGER



Constructed from graphite monolithic blocks of high thermal conductivity.

Short passages induce high turbulence (even at slow flow rates) resulting in remarkably high heat exchange efficiency.

Acids, alkalis, solvents and other corrosive fluids and gases only contact passage walls of impermeable graphite.

No tubes—no cement joints —no heat transfer barriers.

Induced turbulence inhibits film and scale formation; minimises cleaning.

ONLY **POLYBLOC** *HAS ALL THESE FEATURES*

All components consist of standardized interchangeable units. Assembly can be adjusted to accommodate infinite number of process requirements.

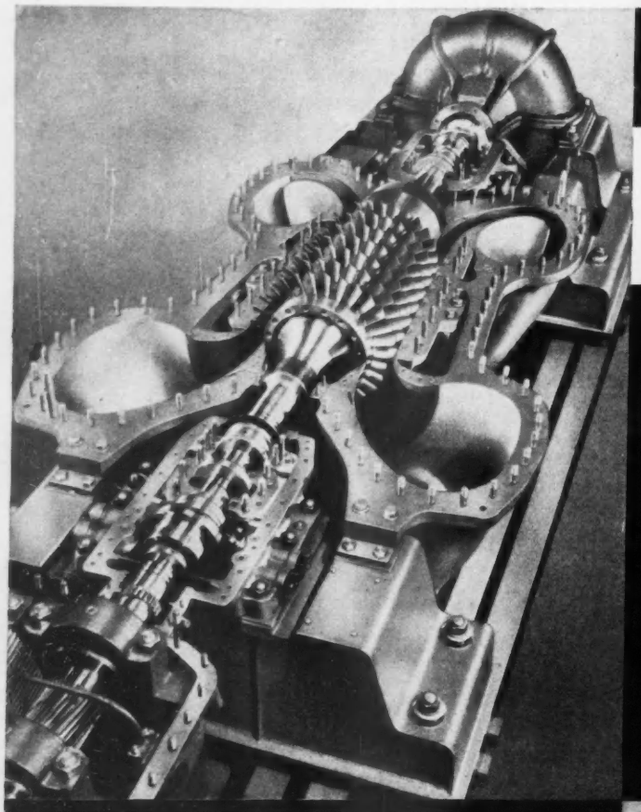
THE WORLD'S MOST VERSATILE GRAPHITE HEAT EXCHANGER

THE SIGN OF GOOD WELDING

IVANHOE TRADE MARK

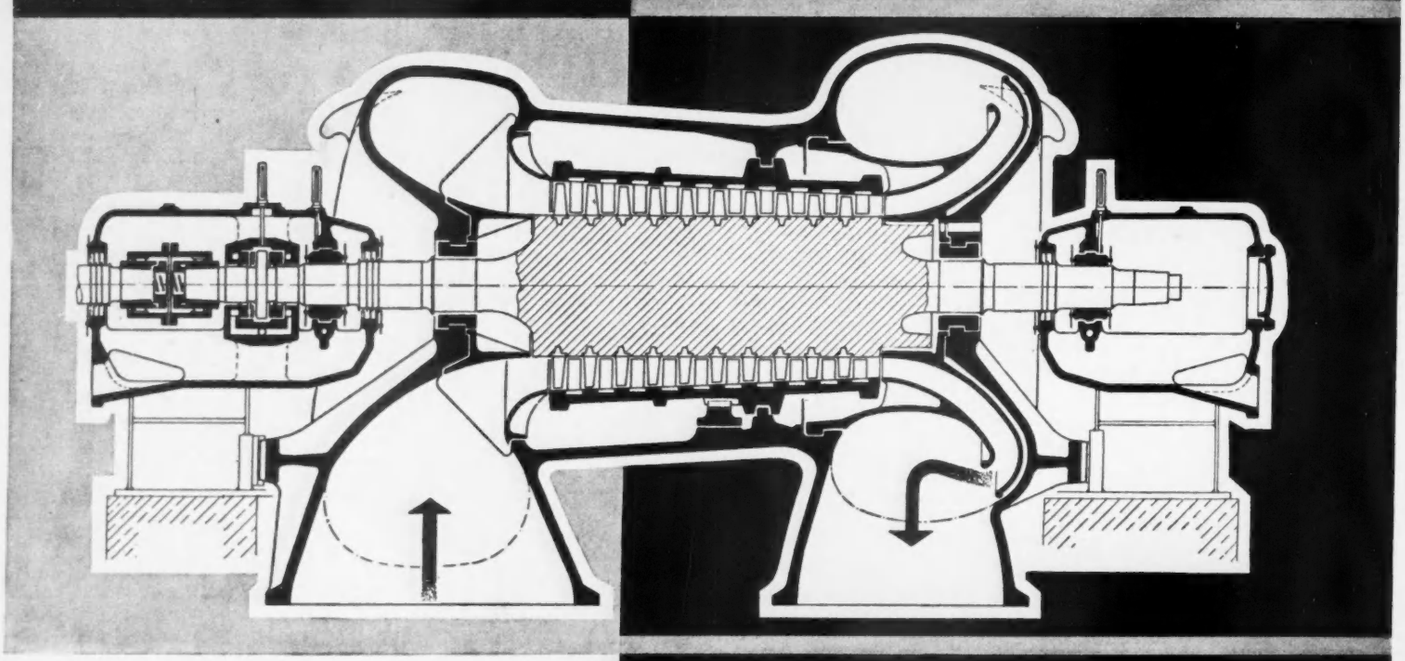
ROBERT JENKINS & CO. LIMITED, ROTHERHAM.

Telephone: 4201 (6 *lines*)



SULZER

The quality of workmanship for which Sulzer is renowned is maintained throughout every machine



Axial Flow Blower for blast furnace air. Type A.C. 7st. 45–70. Supplied to the Societe des Hautfourneau de la Chiers Longwy, on test bed in works, upper casing removed.

Please write for literature to :—

SULZER BROS. (LONDON) LTD.,
31 Bedford Square, London, W.C.1.
Telephone : MUSeum 7890

Drakelow Power Station Project, Nr. Derby

photograph by courtesy of
INTERNATIONAL COMBUSTION LTD • DERBY

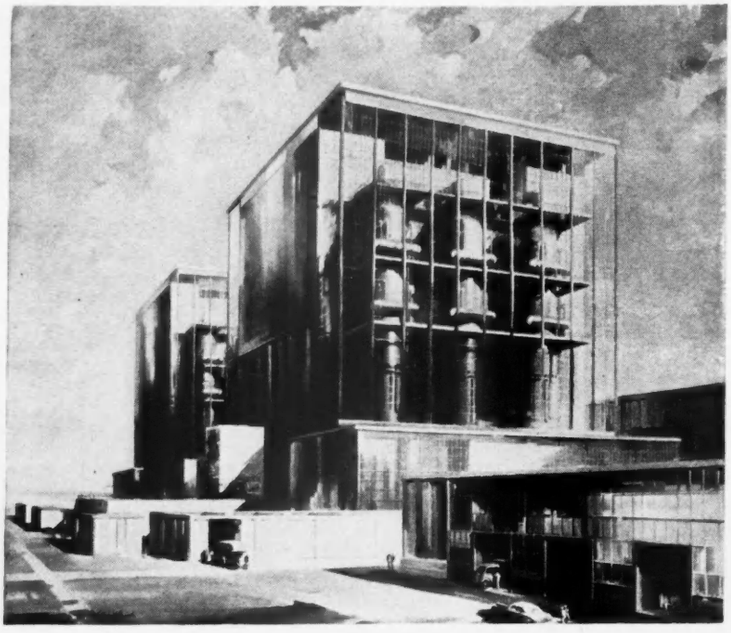
R. H. NEAL & COMPANY LTD.
HEAD OFFICE: PLANT HOUSE · EALING · LONDON W.5
WORKS: GRANTHAM · LINCOLNSHIRE

SEE OUR EXHIBITS ON STAND 61, GRAND HALL, PUBLIC WORKS EXHIBITION, OLYMPIA, NOVEMBER 10-15th, 1958.

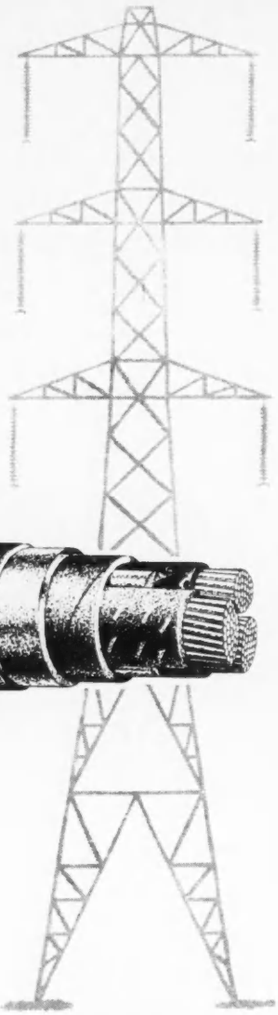
NEAL
MOBILE CRANES

the name behind the best cranes *in any industry*

REMEMBER POPPY DAY



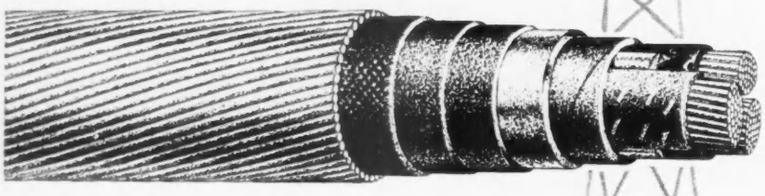
POWER at Hinkley Point



BICC are supplying all the power and control cables, and large quantities of ancillary equipment for this new atomic power station. The installations are to be carried out by the BIC Construction Company.

With an output of 500 megawatts Hinkley Point will be the world's largest atomic station. It is being built for the C.E.G.B. by the English Electric — Babcock & Wilcox — Taylor Woodrow consortium.

The BIC Construction Company have also been awarded the contract to supply and erect approximately 50 miles of 275kV overhead line for the National Supergrid between Hinkley Point and Melksham, Wiltshire.



BICC

transmission equipment

BRITISH INSULATED CALLENDER'S CABLES LIMITED

21 BLOOMSBURY STREET, LONDON, W.C.1

The news behind the headlines is often made at R&M

Have Ransome and Marles been associated with any of the big developments in British Industry ?

We don't hit the headlines—but we often help to make headline news possible. Since the war we have carried out research into design, materials, lubrication and production for a number of important projects. One of these is nuclear power generation. From the early days of Calder Hall our technicians have been tackling fresh problems as new and more powerful reactors are designed.

Are there any other interesting projects ?

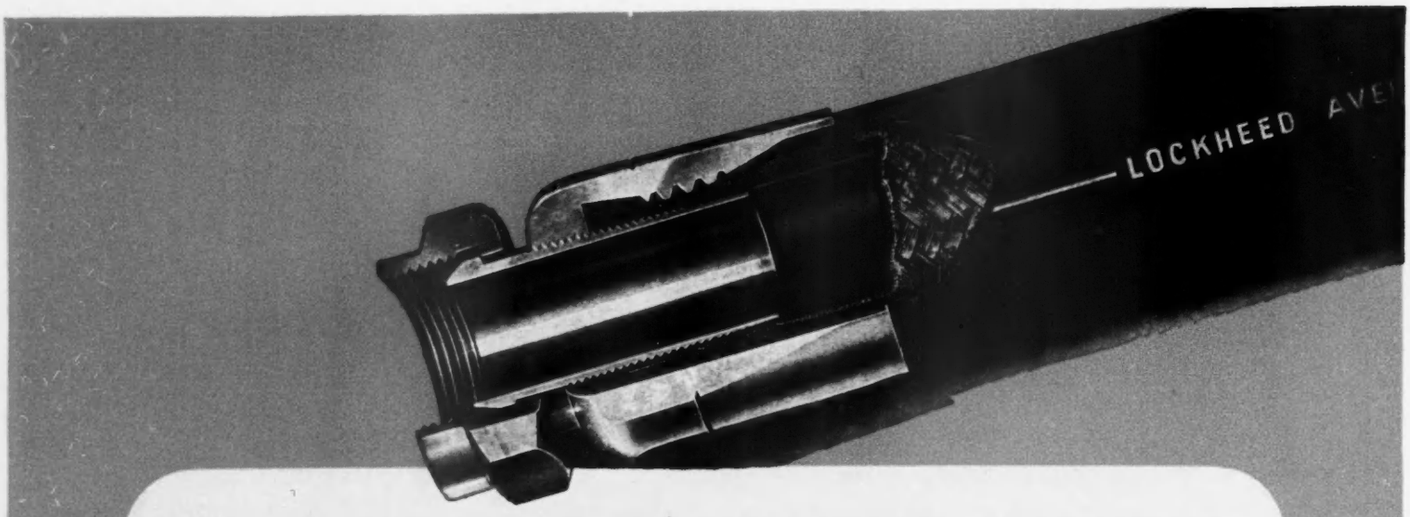
Yes, several. Britain has been achieving a world-wide success with her aircraft engines. Two notable users of R&M Bearings are Armstrong-Siddeley Motors and Bristol Aero Engines. The Proteus engines of the latest Bristol Britannia are of course fitted with Ransome & Marles Bearings.

Then again "automation" is a popular word these days. We at R&M are becoming increasingly "automatic" in many of our processes in shops and offices. We also supply the bearings for the latest electronic machines. Our customers include Powers Samas, Elliott Brothers, IBM and British Tabulating Machines—just another example of the role played by R&M in all fields of industrial development.

Ransome & Marles Bearing Co. Ltd. Newark-on-Trent, England

TELEPHONE · NEWARK 456 AND TELEX 37-306

BALL & ROLLER R&M BEARINGS



New HIGH PRESSURE HOSES

Following the success of their hoses, Lockheed-Avery announce a new range, available with single and double wire braid, with a number of important features.

These hoses are backed by more than 20 years of experience in a wide range of industrial and aircraft hose applications, often in conjunction with other equipment made by the AP group.

The hoses are suitable for pressures ranging from 300-lbs. per sq. in. for 2" bore hose to 4050-lbs. per sq. in. for $\frac{1}{8}$" bore hose.

End-fittings are of steel, with hexagonal sleeves which expedite fitting, and are re-usable.

When desired, swaged-on end-fittings can be supplied for hoses up to $\frac{3}{8}$" bore.

90° elbows and 45° bends are available.

FOUR DIFFERENT LININGS

These new hoses types 77-99 have the advantage that they can be supplied with any one of these four linings:

NITRILE : NATURAL RUBBER : BUTYL : NEOPRENE

A list of compounds, with the lining recommended, can be supplied on request. The longest length of hose obtainable remains at approximately 30 ft. for hoses of $\frac{1}{4}$" bore and over, and approximately 15 ft. for hoses of $\frac{1}{8}$" and $\frac{1}{4}$" bore. Within these limits any desired length of hose assembly can be supplied.

FEATURES

Re-usable steel end fittings for strength and convenience

Hexagon sleeves for ease of assembly

Cadmium plated for corrosion resistance

Choice of four linings

Elbows and bends available

Wire braiding gives great safety.

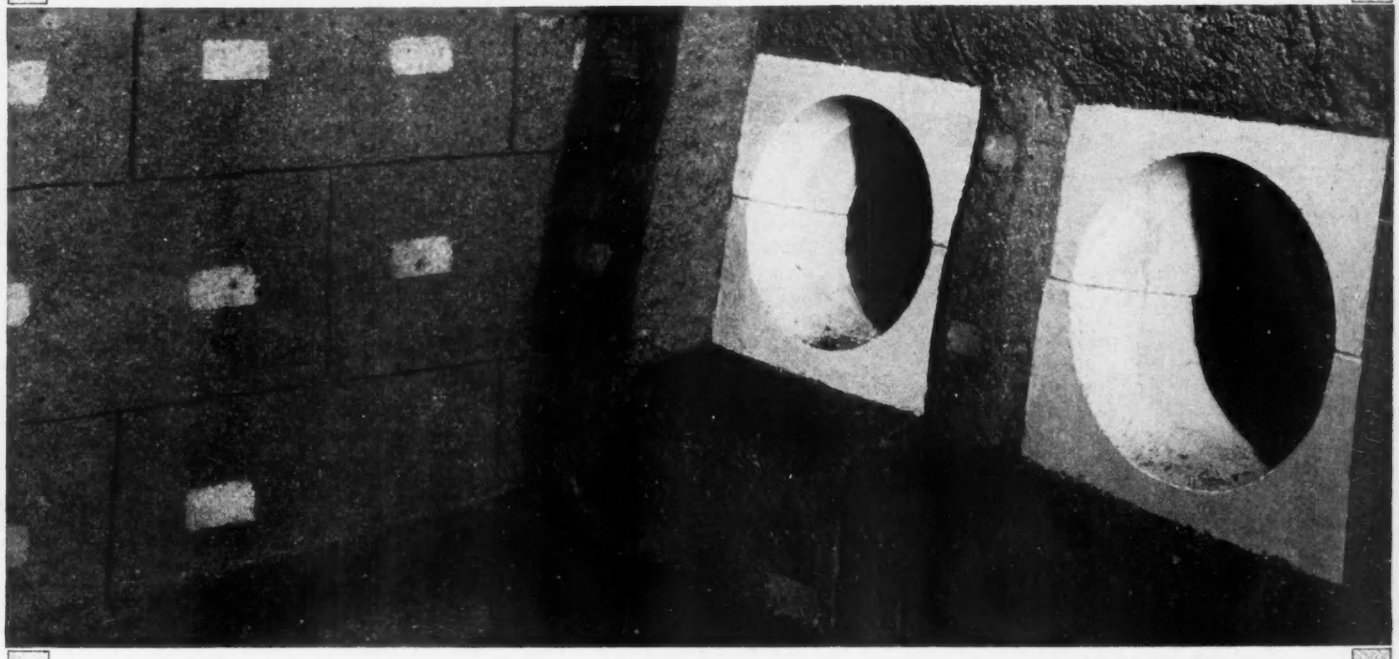
Lockheed Avery

Regd. Trade Mark: Lockheed

AUTOMOTIVE PRODUCTS COMPANY LTD., SHAW ROAD, SPEKE, LIVERPOOL, 24

Tri-Mor Plastics & Castables

MAKE INSTALLATION EASIER, QUICKER AND CHEAPER



Front and side walls of a Queen Mary boiler in Tri-Mor High Temperature Mouldable, with MR 60 anchors. Burner quarls in Tri-Mor High Temperature Castable.

TRI-MOR GRADES

TRI-MOR *Standard Castable*
A medium texture refractory having negligible shrinkage up to 1,350°C. Suitable for casting special shapes or for monolithic structures. Limiting service temperature 1,350°C.

TRI-MOR *High Strength Castable*
A similar refractory to Tri-Mor Standard Castable, but specially developed to have very high mechanical strength over the lower temperature range. Maximum service temperature 1,250°C.

TRI-MOR *High Temperature Castable*
Suitable for face temperatures up to 1,600°C; has an extremely high resistance to thermal shock; used for cast in situ monolithic structures and for pre-cast refractory shapes; can be applied with a cement gun.

TRI-MOR *High Temperature Mouldable*
A plastic refractory for use up to 1,650°C: low shrinkage and a high resistance to spalling. Supplied mixed to the correct consistency for installation.

TRI-MOR *Dense "Guncrete"*
A hydraulic setting refractory with a maximum service temperature of 1,300°C. It has a high resistance to abrasion. Designed for application by cement gun, but can be trowelled.

TRI-MOR *Insulating Castable*
An insulating castable for maximum service temperatures of 1,200°C; low thermal conductivity is its main feature.

TRI-MOR *Insulating "Guncrete"*
Similar to Tri-Mor Insulating Castable but for application by cement gun.

Full details of each grade are available on request.

MORGAN Refractories Ltd

For further information please write to: MORGAN REFRACTORIES LTD. NESTON, WIRRAL, CHESHIRE. TEL: NESTON 1406

NE 138

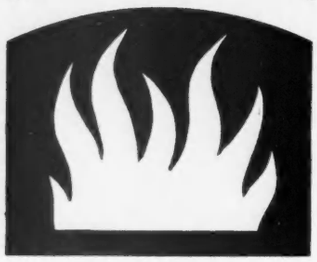
D

WHITE CALCIUM-ALUMINATE CEMENT

(Over 70% Al_2O_3)

IRON COMPOUNDS & SILICA LESS THAN 1%

SECAR



250

Registered Trade Mark

This cement when mixed with appropriate aggregates provides Super-duty Castable Refractory Concrete for service temperatures up to 1,800°C (3,300°F) Refractory Concrete free from Iron Compounds & Silica is now possible for the first time.

A REFRACTORY CONCRETE FOR ANY PURPOSE

SECAR 250

is a product of

Lafarge Aluminous Cement Co. Ltd.

Manufacturers of

CIMENT FONDU

Regd Trade Mark

ALUMINOUS CEMENT

BECAUSE

Almost the entire Refractory field can be covered by Refractory Concretes based on SECAR 250 or CIMENT FONDU.

SECAR 250 concretes have all the well known properties of Ciment Fondu concretes

PLUS

- HIGH PURITY
- HIGH REFRACTORINESS
- HIGH SLAG RESISTANCE
- HIGH COLD STRENGTH
- HIGH SPALLING RESISTANCE
- HIGH CASTING ACCURACY
- HIGH RESISTANCE TO CORROSIVE ATMOSPHERES
- NO SPECIAL PRE-FIRING PROCEDURE

WRITE FOR BOOKLETS 'SECAR 250' AND 'REFRACTORY CONCRETE

LAFARGE ALUMINOUS CEMENT CO. LTD. 73, BROOK STREET, LONDON, W.1. TEL.: MAYfair 8546

AP/48

have you a coupling problem?

Errors in the alignment of connected shafts are, generally speaking, unavoidable. Even when exceptionally favourable conditions do permit of perfect alignment in the beginning, working loads must eventually cause misalignment. Wear of bearings and vibration are two certain factors which contribute to throwing connected shafts out of true, and even changes of temperature may vary alignments. Moss Geared Couplings will be found to be the perfect solution to this problem of retaining efficient operation. Intensive research has enabled us to design a coupling which not only balances alignment errors, but also permits free lateral float to the connected shafts, thus increasing enormously the life of connected machinery.

Moss Gear Couplings are available in a large range of sizes and our illustration shows a rolling mill main drive coupling connecting 20in. diameter shafts.

MOSS GEARS

THE MOSS GEAR COMPANY LTD.
Crown Works, Tyburn
Birmingham 24
Phone: ERDington 1661-6
Grams: 'Mosgear' Birmingham

Spun Cast OR CHILL CAST BRONZE

'LILY' BRAND CHILL CAST PHOSPHOR BRONZE
(CORED OR SOLID)

Produced to the very highest standards in a full range of sizes up to 10½" dia. Supplied as cast or rough machined within 0·010" of finished size.
Note, too, that we supply completely machined bushes, either plain or flanged.

SPUN CAST CORED BAR . . . . .
IN PHOSPHOR BRONZE, LEADED BRONZE, ALUMINIUM BRONZE, GUNMETAL, ETC.

The centrifugal process produces cored bar which is absolutely guaranteed to be free from defects, and we invite enquiries for Phosphor Bronze, Leaded Bronze, Gunmetal, Aluminium Bronze, Cupro Nickel, Copper, etc., either in bar form or rings, part or finished machined, etc. Full range of sizes up to 7" outside dia. by 3" bore.
Length up to 24".

Rely on **CARR**

SPECIALISTS IN THE CASTING OF NON-FERROUS METALS

CHARLES CARR LIMITED

INCORPORATING THE NON-FERREOUS CASTING CO., (B'HAM) LTD.
GROVE LANE SMETHWICK 40 • BIRMINGHAM
TELEPHONE - SMETHWICK 1231-2-3
LONDON OFFICE : 56 HOLBORN VIADUCT, LONDON, E.C.1. TELEPHONE : CITY 3826-3827.

MANVERS CENTRALIZATION SCHEME :

From the top of the newly constructed Coal preparation plant a small section of the immense network of railway sidings

The supply and installation of these sidings and the adjoining trackwork for the new Coal Carbonization and Benzole Rectification Schemes were entrusted to the Eagre Construction Co., Ltd., by the National Coal Board. Over 9,000 tons of Iron and Steel were used in the construction of the forty miles of track and 230 turnouts and Special Point and Crossing layouts comprising the combined railway Sidings.

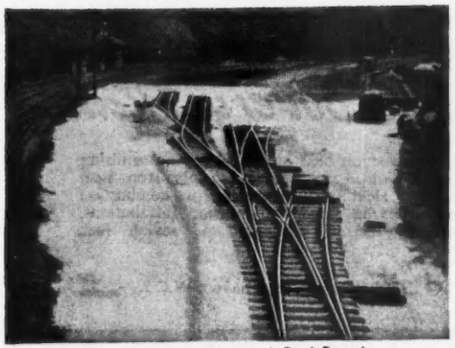
Eagre's skilful planning and practical experience in the day-to-day working of Colliery Sidings ensured that this vast scheme was laid efficiently to schedule, and without the slightest interruption of existing Colliery traffic.

Photograph by courtesy of National Coal Board

WORK BEGINS AT CADEBY :

The National Coal Board again entrusts the Eagre Construction Co. Ltd. with a similar project. Earthworks, Drainage, Track Laying and ancillary works for thirteen miles of Sidings are now in progress at Cadeby Main.

for a complete Track Service



Photograph by courtesy of National Coal Board

In addition to its activities in the Nation's Coalfields, the Eagre Construction Co. Ltd. has worked continuously during the past ten years for British Railways, the Gas Board, the United Steel Companies, and has carried out large Power Station Projects for the Central Electricity Authority.

SURVEY
DESIGN
SUPPLY
INSTALLATION

Whatever the magnitude of your siding requirements, be sure to consult

EAGRE CONSTRUCTION CO. LTD.
East Common Lane SCUNTHORPE Lincs.

EAGRE

Telephone: Scunthorpe 4513-7

LOCOMOTIVES

Designers and Builders of Steam, Diesel and Diesel-electric and Battery Locomotives for all purposes. Flame Proof Diesel and Battery Locos for underground working.

HUDSWELL, CLARKE & COMPANY LIMITED

Railway Foundry, Leeds

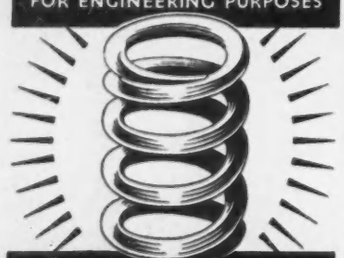
LONDON OFFICE:
120/122 Victoria Street, S.W.1
TELEPHONE:
Victoria 6786

Increase production! by using

SCRIVEN MACHINE TOOLS

CROSTHWAITE FURNACES and SCRIVEN MACHINE TOOLS LTD.
York Street Ironworks, Leeds 9 Tel.: 32411-2
32, Victoria Street, London, S.W.1 Tel.: Abbey 2966

SPRINGS AND SPRING WASHERS
FOR ENGINEERING PURPOSES



Manufactured by
JOHN TONKS & CO LTD.
CENTRAL SPRING WORKS
Furnace Hill, SHEFFIELD, 3
Telephone: SHEFFIELD 24679 Telegrams: TONKS SHEFFIELD 3

ABBOTT & CO. (NEWARK) LTD.
Newark Boiler Works
NEWARK · NOTTS
Telegrams: ABBOT NEWARK 34
Telephone: NEWARK 34

BOILERS and AIR RECEIVERS

See Display Advertisement Oct. 24

THIS MACHINERY—part of a Rolling Mill—was produced by Sheepbridge Equipment Limited to the order of Davy and United Engineering Company Limited of Sheffield

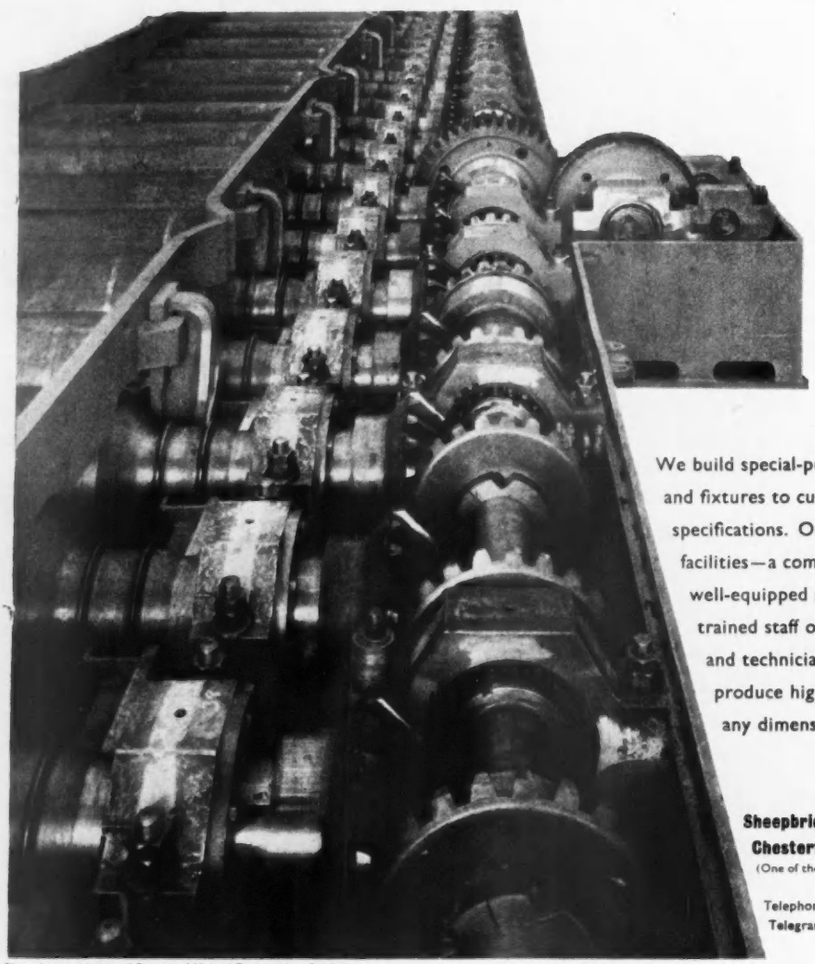


Photo by permission of Davy and United Engineering Co. Ltd.

We build special-purpose machinery and fixtures to customers' specifications. Our production facilities—a combination of modern well-equipped shops and a highly trained staff of craftsmen and technicians—enable us to produce high precision work to any dimensions.

Sheepbridge Equipment Limited
Chesterfield · England
(One of the Sheepbridge Engineering Group)
Telephone: Chesterfield 5471
Telegrams: Sheepbridge Chesterfield

RESISTANCE STRAIN GAUGES

By J. YARNELL, B.Sc., A.Inst.P.

Price 12s. 6d. (Postage 6d.

This book deals with the construction and application of resistance strain gauges and with the most commonly used circuits and apparatus. The strain gauge rosette, which is finding ever wider application, is treated extensively, being introduced by a short exposition of the theory of stress and strain in a surface.

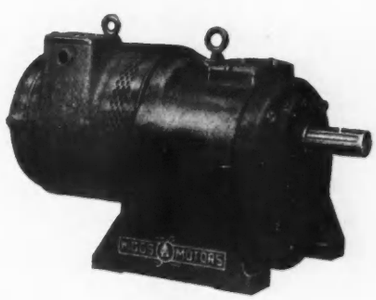
Order your copy through your Bookseller or direct from:—
ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C.2.

Waste Heat Recovery Plant

Specialists in the design and construction of Steam-Raising Plant utilising waste gases, in the Gas, Chemical, and Ceramic Industries; also Iron, Steel and Non-Ferrous Metal Industries; Heat Recovery from internal combustion engines and similar prime movers in Land and Marine Installations. A direct method of increasing thermal efficiency and saving fuel.

Consult the Specialist in Waste Heat Recovery.
SPENCER-BONECOURT-CLARKSON LTD. 28 Easton St., London, W.C.1. *Tel: Terminus 7466*

GEARED MOTOR UNITS



ALL YOUR MOTOR REQUIREMENTS

PRICES COMPETITIVE
DELIVERY - STANDARD STOCK

TRADE MARK
HIGGS MOTORS
CHAIRMAN WALTER F. HIGGS M.I.E.E. LTD
BIRMINGHAM 6 ENGLAND

AGENTS AND BRANCHES COVER THE WORLD

control and regulation

Valves to regulate flow, and to perform a variety of safety and other functions, under almost any conditions of service are manufactured by Cockburns of Cardonald.
The range of standard Cockburns Valves covers the majority of applications, and the design staff have the experience and knowledge to develop valves for special purposes.

COCKBURNS VALVES

COCKBURNS LTD
CARDONALD GLASGOW SW1

London Office
175 PICCADILLY W1

North Eastern Depot
FISH QUAY NORTH SHIELDS

NEO-K-TEX

THE JOINTING MATERIAL WITH THESE ADVANTAGES

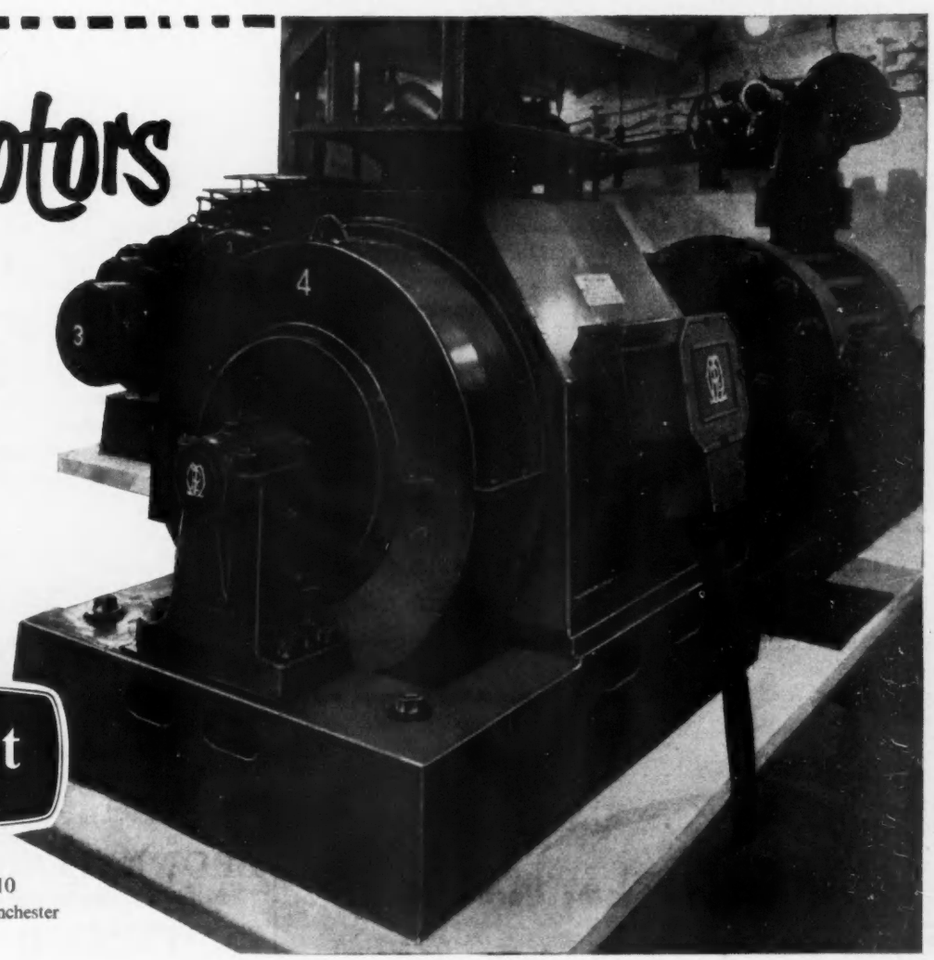
Proved by many leading industries to give complete resistance to oil, petrol and most industrial solvents. Permanently flexible, non-spreading and with excellent recovery properties, Neo-K-Tex is today's most reliable jointing material. Supplied in sheets in a large range of special-purpose quantities and gauges, or cut to any required shape, for gaskets, washers, mouldings etc.

RESISTS
OIL, PETROL, MOST INDUSTRIAL SOLVENT WATER.

KAUTEX LTD

ELSTREE WAY, ELSTREE, HERTS
Telephone : Elstree 1777/8/9 and 1770

Pumps & motors

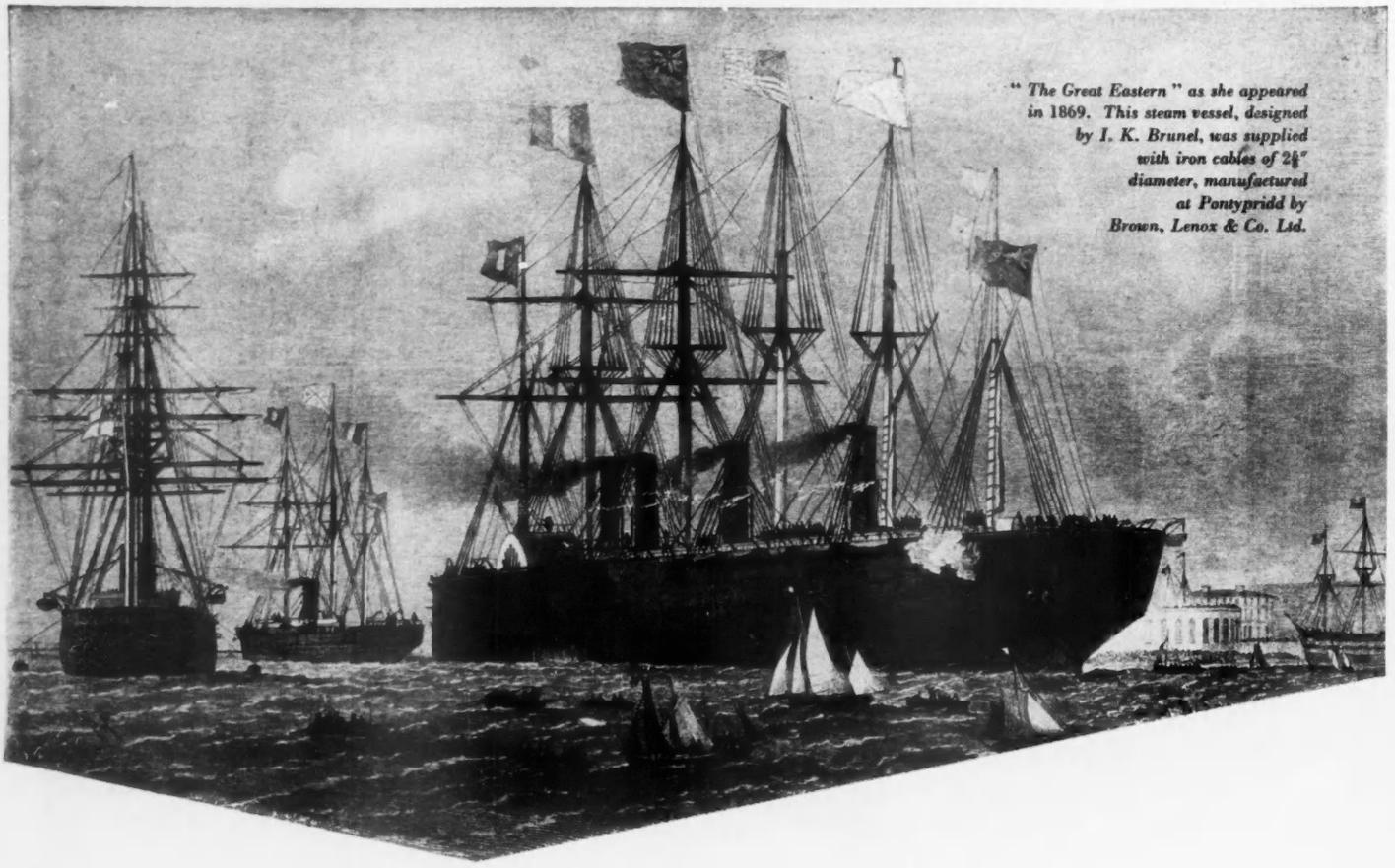


This Mather and Platt modern squirrel-cage drip-proof induction motor, which is direct-on started with a low starting current, drives a mine drainage pump in a Durham colliery. Behind it can be seen an earlier installation of drip-proof wound rotor induction motors which drive similar pumps. The motors are rated at 650 b.h.p., 2,750 volt, 1,475 r.p.m., and each Mather and Platt Plurovane pump delivers 1,500/1,600 g.p.m. against a 1,100/960 ft. head.

703

Mather & Platt
LIMITED

PARK WORKS, MANCHESTER, 10
Telephone: COLlyhurst 2321. Telegrams: Mather, Manchester



" The Great Eastern " as she appeared in 1869. This steam vessel, designed by I. K. Brunel, was supplied with iron cables of 2¼" diameter, manufactured at Pontypridd by Brown, Lenox & Co. Ltd.

From Napoleon to Elizabeth II . . .

The founder of this Company *invented* and manufactured the first chain cable ever to be used for the mooring of ships ; this was in 1806.

From 1808 until 1916 the Company unbrokenly, year by year, was awarded the contract for the British Admiralty chain cable requirements.

Today, Brown, Lenox & Co. Ltd. is known all over the World as one of the leading firms specialising in the design of moorings—and in the manufacture of the components of which a mooring is made up.

The Company operates one of the very latest types of automatic machines for the production of ***high tensile electric flash butt welded steel chain cable.*** *Chain cable is made* ***in sizes up to those suitable for mooring the largest vessels afloat.***

The following publications are available:

- **MOORINGS AND BUOYS** (32 Pages)
- **BLeCO MOORING AND SHIPS CHAIN CABLE** (8 Pages)
- **BLēCO HIGH TENSILE STEEL CHAIN CABLE** (Leaflet)
- **SHIPS CHAINS, ANCHORS & ANCILLARY GEAR** (16 Pages)

Copies of any, or all, of these publications will be sent free of charge, and postage paid.

Brown Lenox

Illustration by courtesy of the Trustees of the National Maritime Museum.

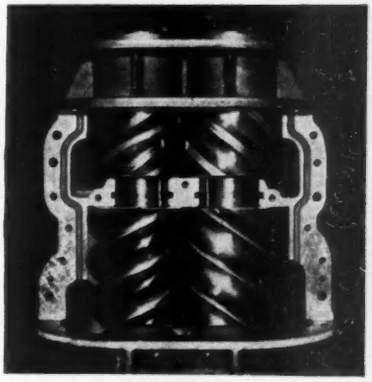
An announcement by the Marine Division of

BROWN, LENOX & COMPANY LIMITED
Associated Company : Brown, Lenox & Co. (London) Ltd., Millwall, E.14
PONTYPRIDD GLAMORGAN

THE WORLD'S FIRST PORTABLE ROTARY SCREWCOMPRESSOR

THE ATLAS COPCO TWIN-AIR

- This Compressor—based on a Swedish invention—is completely different in design from conventional rotary types.
- After extensive field tests Atlas Copco Twin-Air Portables were put into quantity production earlier this year and were first exhibited at the St. Eriks Fair in Stockholm last August.
- These Portable machines embody all the know-how gained from two years operating experience with Twin-Air Stationary Compressors installed in mines and industrial plants.
- The Twin-Air has no wearing parts in the two oil-flooded compression chambers, with the result that maintenance and overhauls are kept to a minimum.
- With the Twin-Air you get an overall operating efficiency which only a two stage machine can give.
- The Rotary Screw design guarantees a smooth air-flow, free from surging characteristics.
- The first models in this new range are machines of 390 c.f.m. and 630 c.f.m. Both 100% air-cooled, diesel-powered units.



The main components of the Twin-Air Compressor are two screws which intermesh without metallic contact.

PUBLIC WORKS EXHIBITION, OLYMPIA, LONDON, NOVEMBER 10th-15th, 1958

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

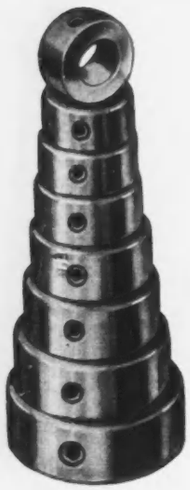
Write to Atlas Copco AB, Stockholm 1, Sweden, or contact your local company or agent. In Britain write to Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middlesex. P10

E

FORDSMITH OF MANCHESTER

IN ALL SIZES

COLLARS



MANUFACTURED ENTIRELY FROM THE SOLID BAR IN OUR OWN WORKS!

Generously dimensioned on both width and outside diameter and fitted with unbreakable setscrew

WRITE FOR LISTS—

FORDSMITH OF MANCHESTER

SPECIALISTS IN REPETITION WORK OF EVERY KIND

H. FORDSMITH
LIMITED

HADFIELD ST. WORKS
CORNBROOK • MANCHESTER, 16
Telephone: Trafford Park 1615-6

There is no substitute for experience

Experience counts in every walk of life, but in no other job is experience so vitally necessary as in the design and building of machines such as large power presses, where the ability to turn out large numbers of high quality pressings at an economic rate depends so much on inbuilt robustness, accuracy and reliability.

The up-to-date design and extra massive proportions of all C.W. presses are not the sole features which give C.W. presses their absolute dependability but it is also the real old fashioned craftsmanship such as the accurate hand scraping of every slideway and the careful bedding of every main bearing that makes the difference between a COWLISHAW WALKER POWER PRESS and just another press.

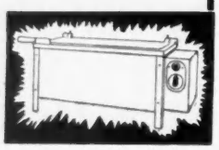
COWLISHAW, WALKER & CO. LIMITED

Biddulph, Stoke-on-Trent. Telephone: Biddulph 3254. Telegrams: "Cowlishaw," Stoke-on-Trent
LONDON OFFICE: 17 Victoria Street, S.W.1 Telephone: ABBey 6693

PROTECTION
against **ROUGH HANDLING**

"GLOSCOAT" is a plastic protective packaging material for the protection of tools, machine parts and simple assemblies. It is applied by dipping and removed by stripping. It protects against corrosion, rust and rough handling and can reduce packaging time by at least 60 per cent man-hours.

Type L. Tank.



GLOSCOAT

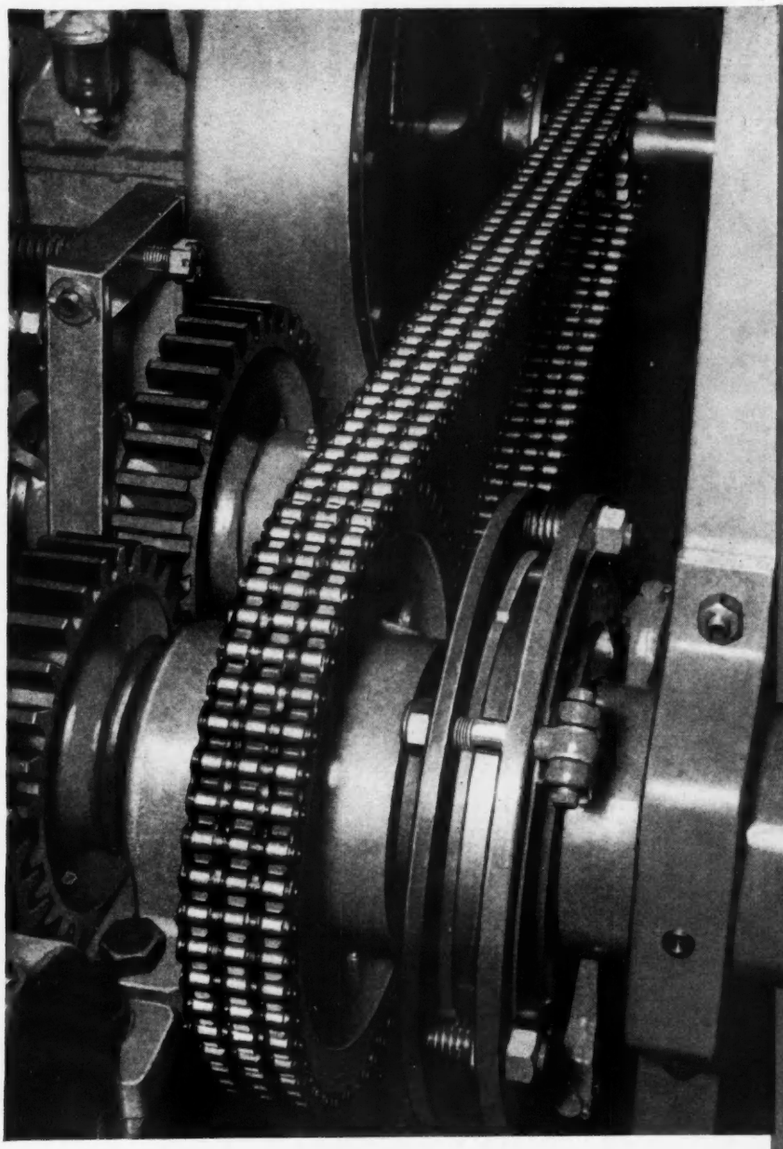
Manufactured by Glostics Ltd., Gloucester, England.

***STRIPPABLE HOT DIP* PROTECTIVE COATING**

SOLE DISTRIBUTORS FOR THE U.K.
Write Dept. BC/3 for full technical details.

J. M. STEEL & CO. LTD.

36/38 Kingsway, London, W.C.2. Tel.: Hol. 2532/5
Branch Offices:
51, South King St., Manchester 2 Tel.: Deansgate 6077/9
45, Newhall St., Birmingham 3. Tel.: Central 6342/3

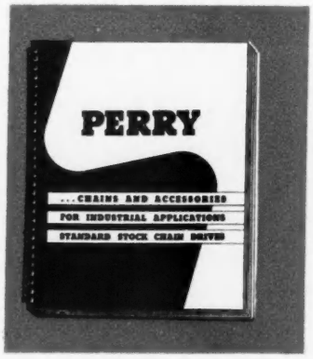


PERRY

Chains and Chain Drives

Illustrated is the main drive from power unit to power take off by a PERRY No. 34612 ½" pitch × .460" wide triplex roller chain on the Jones K.L. 44 Mobile Crane. Photograph by courtesy of Messrs. K. & L. Steelfounders Limited.

— for continuous and dependable service under all conditions

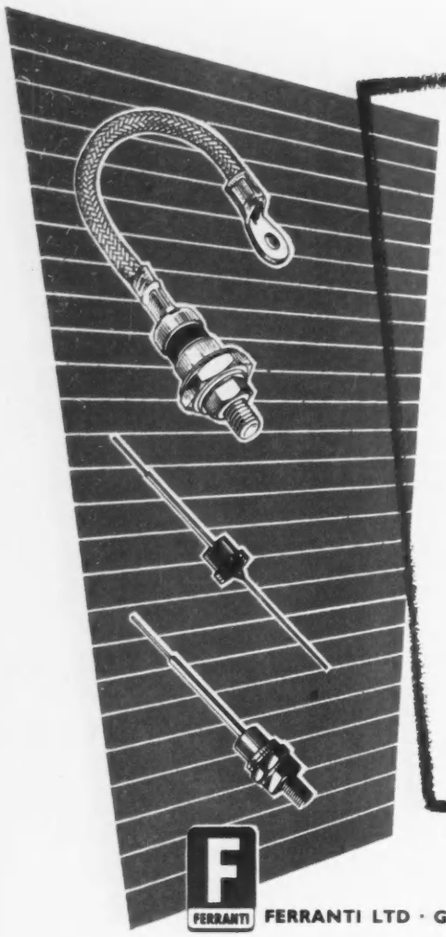


Backed by over seventy years' specialised experience in the manufacture of roller chains to industry throughout the world, PERRY Chain and Chain Drives are available from stock for virtually every industrial application. Write for your free copy of our profusely illustrated Handbook which describes in detail the wide range of PERRY Roller, Bush and Balance Chains, Long Pitch Chains, Chain Drives and Attachment Plates — If you have a Chain Drive problem, let PERRY solve it for you.

Chain makers to industry for over seventy years.

PERRY OF CHAIN FAME

PERRY CHAIN COMPANY LIMITED
TYSELEY, BIRMINGHAM 11
(A Division of the Perry Group)



FERRANTI

DIFFUSED JUNCTION POWER RECTIFIERS

Ferranti offer a range of hermetically sealed rectifiers with peak inverse voltage ratings up to 300 volts, and rectified current from 100 mA. to 30 amps. from a single convection cooled diode.

SPECIAL FEATURES

- More power in smaller space.
- High AC to DC conversion efficiency.
- Excellent regulation.
- Reliable operation at high temperature.
- Minimum maintenance.
- High forward and very low reverse current.

Ferranti Silicon Rectifiers are rigorously tested to Service and Industrial Specifications covering vibration, shock and humidity, and are suitable for Airborne, Marine and Industrial Electrical applications.

Data Sheets and Application Reports are available and will be supplied on request.

FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS *London Office:* KERN HOUSE, 36 KINGSWAY, W.C.2.

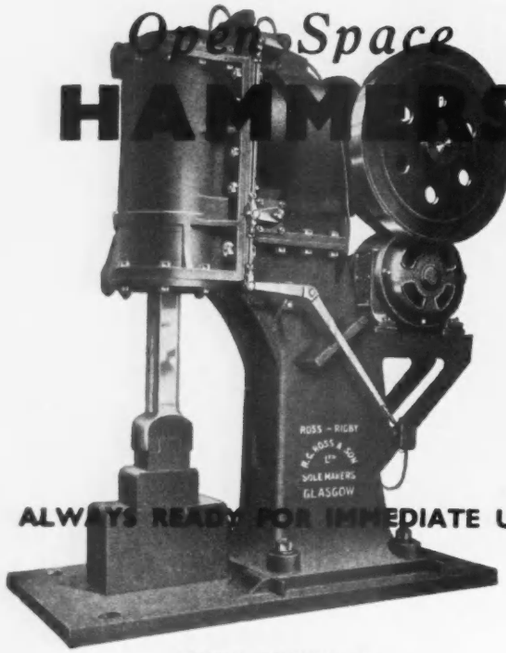
FE185/2

"ROSS-RIGBY"

ELECTRO-PNEUMATIC

Open Space

HAMMERS



ALWAYS READY FOR IMMEDIATE USE

ORIGINAL DESIGNERS AND PATENTEES OF THE FAMOUS "RIGBY'S PATENT" STEAM HAMMER.

ROSS

R. G. ROSS & SON LTD.

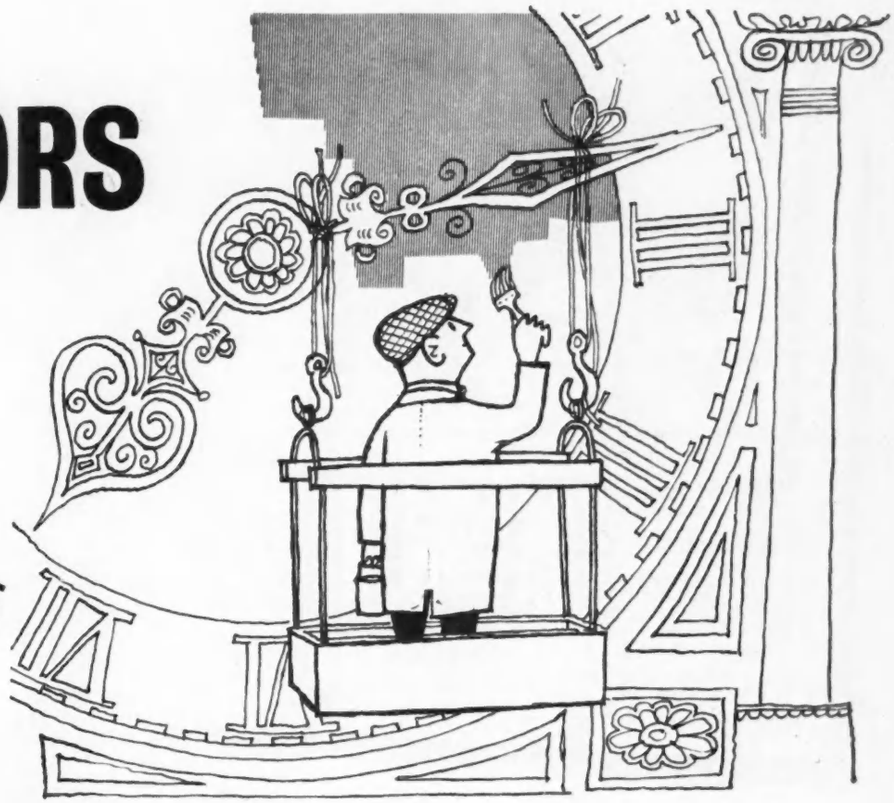
EGLINTON ENGINE WORKS
120 TRADESTON STREET
GLASGOW, C.5.

Telegrams—"Glenros, Glasgow" Telephone—South 2283 (4 lines)

ESCALATORS

STUDY IN MOTION AND TIME

REMEMBER POPPY DAY



Each of the ten escalators installed for Messrs. Lewis in the Haymarket has a speed on incline of 90 f.p.m. and a carrying capacity of 8,000 persons per hour.

To this picture of cold efficiency must be added the dignified yet charming air created by the soft-glow, dove-grey matt finish of the Formica panels and the polished aluminium-alloy deckings and mouldings.

J. & E. HALL LIMITED

ESCALATOR, LIFT & REFRIGERATION ENGINEERS

DARTFORD - KENT **Tel: DARTFORD 3456**

LONDON OFFICE: 10 ST. SWITHIN'S LANE, E.C.4. Tel: MANSION HOUSE 9811

BRANCHES IN MANCHESTER, NEWCASTLE, BIRMINGHAM, BRISTOL and GLASGOW

AP93

Electrically Butt Welded Steel Pipe and Specials from 7 in. to 72 in. diameter by Alfred Allen.

Contact Alfred Allen!
Can't be beaten for Pipework - and they do all types of specials as well as Flanges, Pipe Supports supporting steelwork.
B. D.

alfred allen & SON LTD
LOWER GORNAL, Nr. DUDLEY
London Office: 23 LAWRENCE LANE, E.C.2. TEL: MONARCH 2978
A2186

...then the name that SPRINGS to mind is...

M. LYNCH & SON LTD
MILL WHARF, CANAL ROAD, STROOD, KENT
TEL. STROOD 7545-6 GRAMS. LYNCH, STROOD

MERCHANTS & SUPPLIERS • STOCKHOLDERS OF STRUCTURAL STEEL

Mr. H. F. SPENCER—Managing Director of RICHARD THOMAS & BALDWINS LTD. writes:—

"Although we have our own fuel engineering department occasions arise when we could do with additional qualified staff. A Regular Service Agreement with N·I·F·E·S provides us with a call on fully trained reserves.

In my opinion no business is too big or too small to benefit from a similar arrangement."

H. F. Spencer

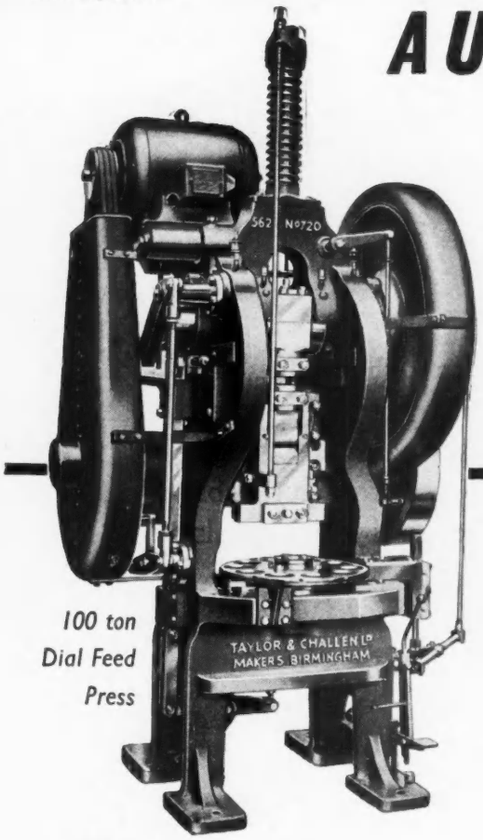
CALL IN N·I·F·E·S — INDUSTRY'S OWN NON-PROFIT-MAKING SERVICE FOR ADVICE ON THE EFFICIENT USE OF ALL FUELS, HEAT AND POWER.

For address of nearest Area Engineer write to:—

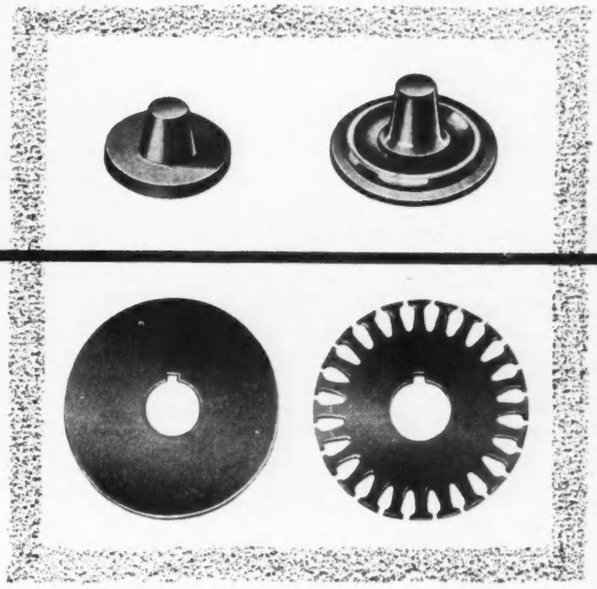
N·I·F·E·S *National Industrial Fuel Efficiency Service*

Head Office: **71 GROSVENOR STREET LONDON W1** · *Telephone:* Hyde Park 9706

AUTOMATIC FEED PRESSES



100 ton Dial Feed Press



WE ALSO MAKE

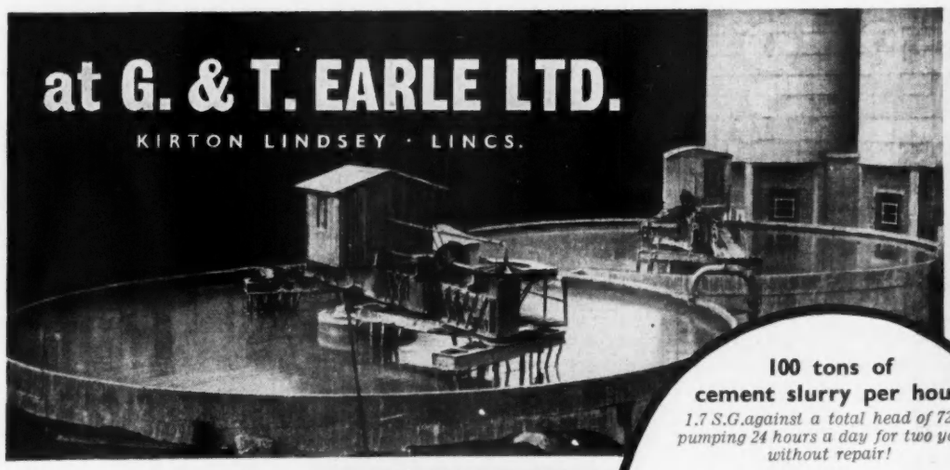
Power Screw Presses
Double Action type Drawing Presses
Single and Double Crank Presses
Open-fronted Presses
Double sided Presses
Cartridge machinery
Minting machinery

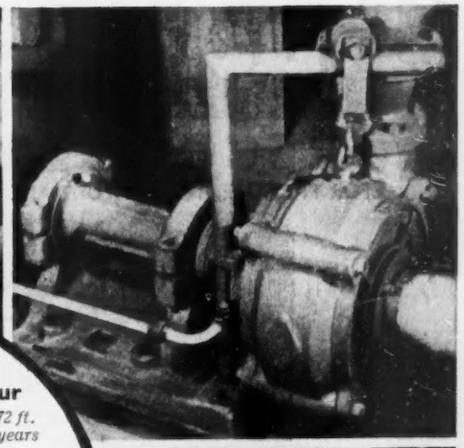
MEMBER

TAYLOR & CHALLEN LTD. BIRMINGHAM 19

at G. & T. EARLE LTD.

KIRTON LINDSEY · LINCS.





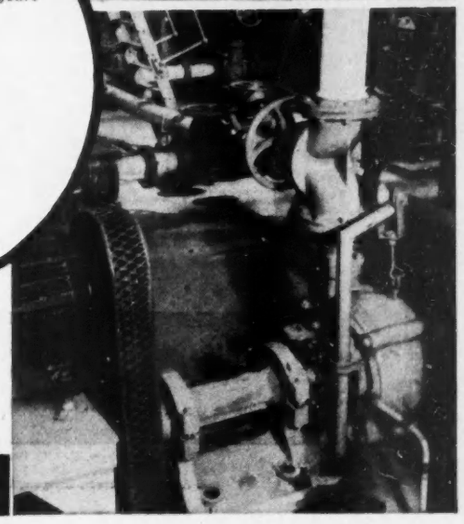
100 tons of cement slurry per hour

1.7 S.G. against a total head of 72 ft. pumping 24 hours a day for two years without repair!

one LINATEX pump leads to another SEVEN

Pumping away in this cement works after two years continuous operation, S.4 EL.127 is in the proud tradition of Linatex Pumps which are standing up to tough assignments in every branch of industry throughout the world.

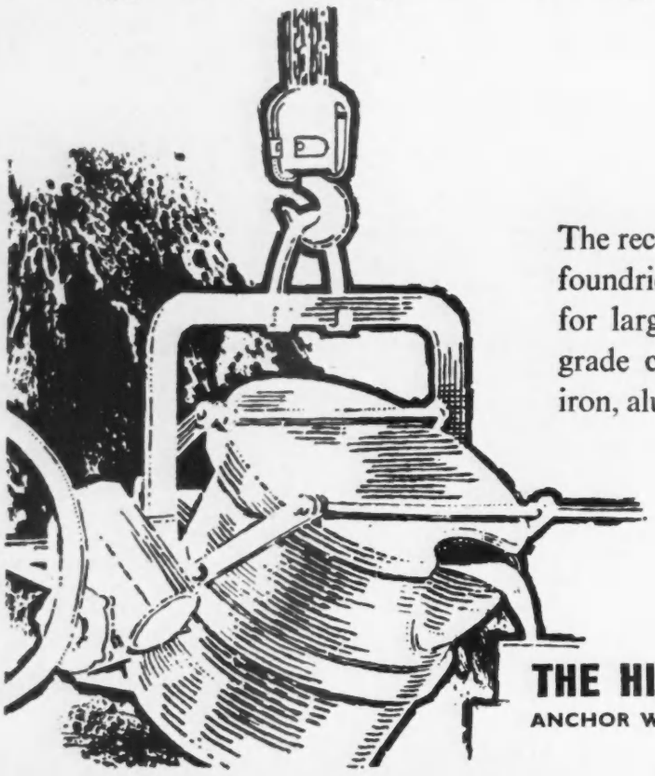
Linatex-lined throughout, wear and corrosion resistant — THE LINATEX PUMP OUTLASTS ALL OTHERS



P.50

Ask to be put in touch with our Resident Engineer for YOUR area
WILKINSON RUBBER LINATEX LTD · CAMBERLEY · SURREY Phone: Camberley 1595

For castings —— specify HILLTOP

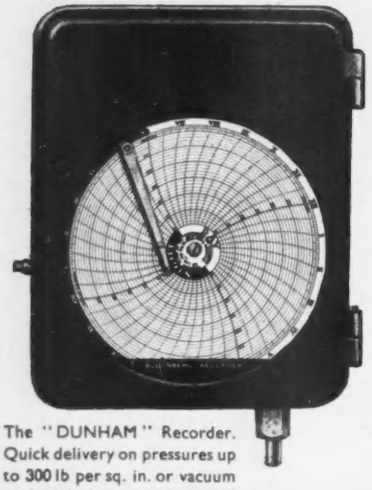


The recent extensions to the Wednesbury foundries enable Hilltop to accept orders for large and small quantities of high-grade castings in grey iron, malleable iron, aluminium alloy, and yellow metals.

THE HILL TOP FOUNDRY CO., LTD.
ANCHOR WORKS, SMITH ROAD, WEDNESBURY, STAFFS.
Phone: Wednesbury 0294

Budenberg

RECORDERS
FOR PRESSURE, TEMPERATURE AND SPEED



The "DUNHAM" Recorder. Quick delivery on pressures up to 300 lb per sq. in. or vacuum with 24 hour record and spring clock.

BUDENBERG GAUGE CO. LTD.,
BROADHEATH, Nr. MANCHESTER

Tel: ALTrincham 2617 (3 lines)
Regency House, 1-4 Warwick St., London, W.1. Phone: GERrard 4822-3. Grams: Pyrometer, Piccy, London
62 Robertson Street, Glasgow, C.2. dm BU. 35

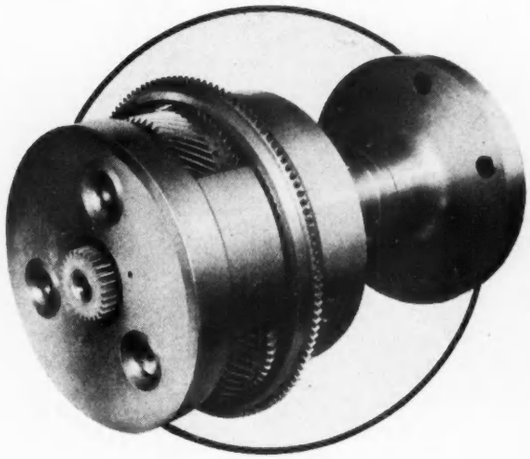
IN THE NEW SINGAPORE

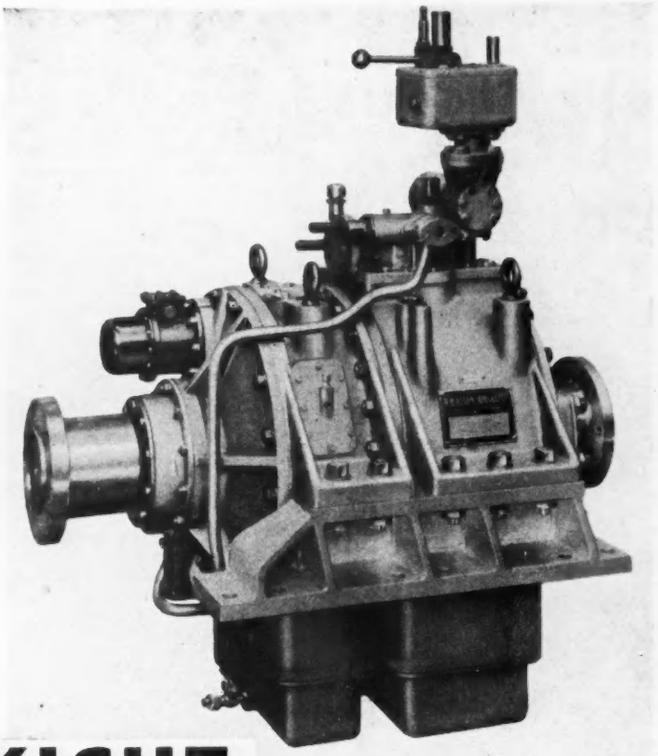
Aluminium Satin Silver Anodised Kinrod Grilles installed on the American International Assurance Building bring the triple advantage of pleasing design, perfect visibility, and complete security. Precision-built, they are guaranteed for workmanship and materials.

KINROD GRILLES By the makers of— Kinnear Shutters & Kinylon Grilles

Please send for illustrated leaflet 76. **ARTHUR L. GIBSON & CO. LTD**
Twickenham, Middlesex. Telephone Popesgrove 2276. Birmingham: Highbury 2804 Glasgow: Halfway 2928. Manchester: Central 1008. Cardiff: 51428.

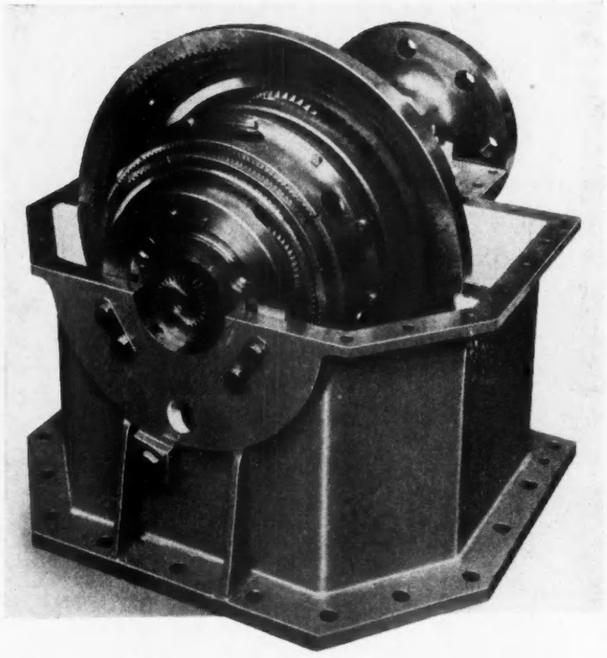
Double-helical epicyclic speed-reduction gear assembly for 1,000-kW turbo-alternator. Speeds: 9,000/1,500 r.p.m.





ALLEN-STOECKICHT
Patented DOUBLE-HELICAL
EPICYCLIC GEARING

Reverse/reduction epicyclic gear unit for diesel engine main propulsion (550 h.p.). Speeds: Ahead—1,000/625 r.p.m. Astern—1,000/500 r.p.m.



Double-reduction, double-helical epicyclic gear (with gear-case cover removed) for steam turbo-generator. Gear-box power: 650 h.p. Speeds: 16,500/600 r.p.m.

Allen-Stoeckicht patented double-helical epicyclic gearing offers a compact speed-reduction or speed-increasing unit for the transmission of a wide range of powers at varying speed ratios.

The weight and space requirements of an epicyclic gear are considerably reduced when compared with those of conventional gears for the same design life and factors of safety. Also, the absence of transverse forces on either the input or output shaft eliminates the need for high-speed pinion bearings, the pinion or sun wheel being supported by the planet wheels and connected to the high-speed shaft by means of a double gear-tooth-type coupling. This and other important advantages are provided by the Allen-Stoeckicht patented design of double-helical gearing.

Further details of this type of gearing for any individual application will be supplied on request. An experienced technical staff is available at Atlas Works, Pershore, Worcestershire, and throughout the United Kingdom, to advise on the use of epicyclic gearing for any industrial or marine application. **Gear units are built for powers up to 20,000 h.p. with ratios of 12:1 in a single train, and 144:1 in a double train unit.**

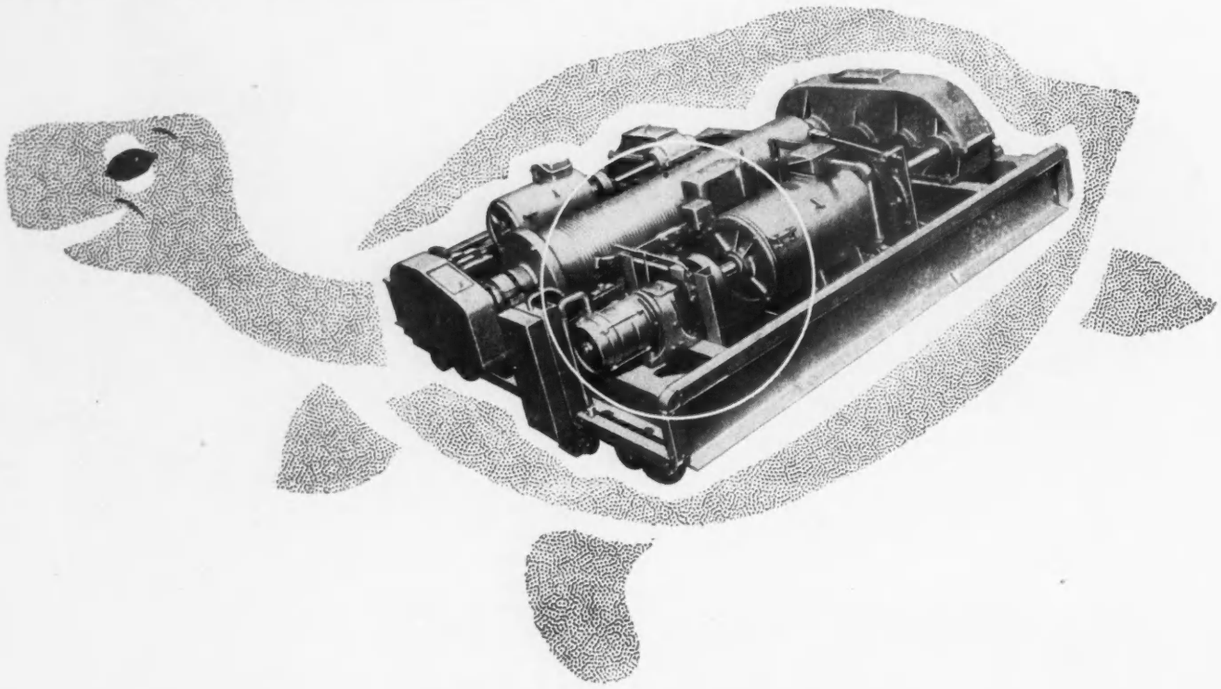
All enquiries to

Atlas Works, Pershore, Worcs.

W. H. ALLEN SONS & Co LTD

BEDFORD ■ ENGLAND

slowly but surely . . .



Slomax Creep-Speed Control

This system was developed to meet the need for a controlled creeping speed for all motions of cranes on A.C. supply where precise slow-speeds are required.

The success of this well-tried system, proved under arduous conditions, lies in its extreme simplicity.

The device is entirely automatic and fool-proof.

The main motor is not energised when the creeping speed is in operation.

The operating circuits being electrically inter-locked, it is impossible for the main motor and the Slomax motor to operate simultaneously.

Slomax control permits an unlimited ratio between creeping and normal speeds, and whilst ten to one is usual, a ratio of fifty to one is not uncommon for specialised duties.

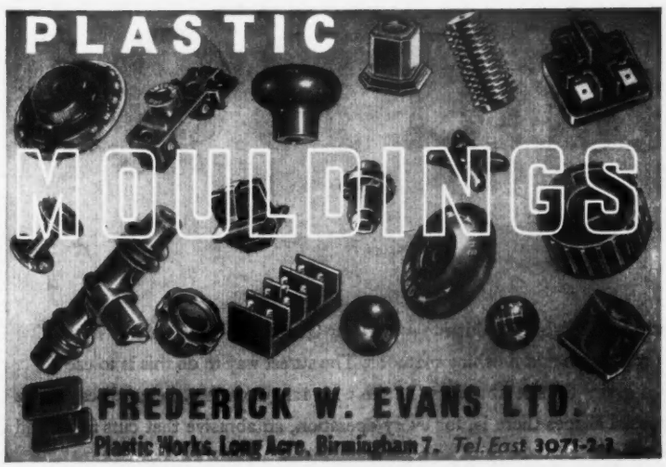
A further advantage is that where precise creeping speeds are required for specialised operations, the Slomax control will ensure a predetermined creeping speed, irrespective of the load on the hook.

THE WHARTON CRANE & HOIST CO. LTD.

REDDISH STOCKPORT ENGLAND

Phone : Heaton Moor 2227. Grams : "Gallant, Manchester." Code : Western Union

LONDON: Lincoln House, 296/302 High Holborn W.C.1.	Phone: Chancery 7911.	Grams: Chancery 7911.
SCOTLAND: Fisher-Baxter & Co., 140 West George Street, Glasgow C.2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow.
MIDLANDS: A. R. Holland & Son, 89 Cornwall Street, Birmingham 3.	Phone: Central 1457.	Grams: Central 1457, Birmingham.
SOUTH-WEST: R. C. Collins, 48 Westbourne Road, Penarth, Glamorgan.	Phone: Penarth 1527.	Grams: Penarth 1527.
NORTHERN COUNTIES: Fisher-Baxter & Co., 140 West George Street, Glasgow C. 2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow
NORTHERN IRELAND: General Engineering Products Ltd., 7/9 Great Patrick Street, Belfast.	Phone: Belfast 23743.	Grams: Belfast 23743.
EIRE or SOUTHERN IRELAND: Charles Nolan & Co., 2 Parker Hill, Lower Rathmines Road, Dublin.	Phone: Dublin 93510.	Grams: Dublin 93510.
CANADA: Marshall Equipment Co. Inc., P.O. Box 28, 61 Victoria Avenue, Dorval Station, P.Q.	Phone: Melrose 1-3528.	Grams: Marquipco, Montreal.

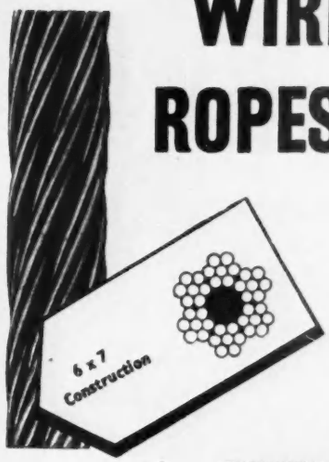


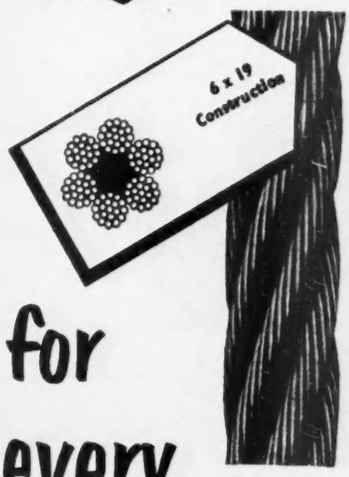
NORRIS BROS. LTD.
have teams available to undertake
DESIGN, DETAILING and DEVELOPMENT
in the following fields :-

- Aeronautical Engineering
- Chemical Plant
- Electrical Engineering
- Mechanical Engineering
- Mechanical Handling
- Nuclear Engineering
- Plant Layout
- Production Tooling
- Servo Mechanisms and Automation
- Special Machines and Projects
- Structure and Reinforced Concrete, etc.

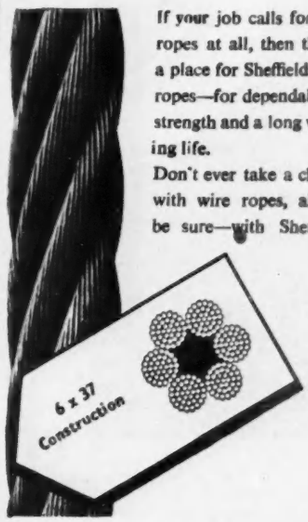
53 VICTORIA STREET S.W.1
– TEL. ABBEY 6132 –

SHEFFIELD WIRE ROPES





for every purpose



If your job calls for wire ropes at all, then there's a place for Sheffield Wire ropes—for dependability, strength and a long working life.
Don't ever take a chance with wire ropes, always be sure—with Sheffield.

Also makers of the "RAM" RAILWAY WAGON PINCH BAR.

THE SHEFFIELD WIRE ROPE CO. LTD.
DARNALL, SHEFFIELD, ENGLAND

GLENBOIG
Firebricks
FOR EVERY INDUSTRY

BOILER FURNACES on Land and Sea

The **GLENBOIG** range includes

42/44% Al_2O_3
GLENBOIG Al
GLENBOIG Al CROWN

36/38% Al_2O_3
GLENBOIG
GLENBOIG CROWN
CASTLECARY

33/34% Al_2O_3
DYKEHEAD · GEM

GLENBOIG

THE GLENBOIG UNION FIRE CLAY CO. LTD., GLENBOIG, LANARKSHIRE, SCOTLAND
EXPORT AGENTS: GENERAL REFRACTORIES LTD., GENEFAX HOUSE, SHEFFIELD, 10

H.P. and B.Q.?

You can have Higher Production *and* Better Quality too—but only by improving your preparation and finishing methods. The surest way to do this is to use E.A.C. 'shaped-grain' flexible abrasives. In the wide range of E.A.C. belts, discs, sheets and special shapes there is, for every operation, an abrasive that cuts faster and wears longer.

The better performance of E.A.C. abrasives is due to advanced manufacturing techniques. A new £100,000 coating plant recently built by E.A.C. incorporates such features as electrostatic application, Beta-Ray thickness control and automatic temperature and humidity control.

Finding the right abrasive can save you money. We will gladly send samples and prices of the most suitable abrasives for any operation in any trade.

BACKSTAND POLISHING

The use of abrasive bands on Backstand Idler machines has considerably widened the sphere of rough grinding and all types of polishing and finishing operations. Rate of stock removal is much higher than with dressed bobs, output is up, costs per unit are reduced, and fewer operations are necessary, particularly with non-ferrous metals. The finish obtainable with E.A.C. electro-coated belts is much superior to that produced with hand-coated bobs or solid wheels.

EAC LIMITED

coated abrasives

ENGLISH ABRASIVES CORPORATION LTD
Marsh Lane, Tottenham, London N.17 Tel: TOTtenham 5057

Subsidiary Companies
THOS. GOLDSWORTHY & SONS LTD
THE HELVETIA ABRASIVES CO. LTD
LONDON ABRASIVES LTD

arteries of industry

As the development of world resources accelerates—extra shipping, refinery investment, industrial expansion, nuclear applications—the demand for top quality pipework increases.

INDUSTRIAL · MARINE · REFINERY · NUCLEAR

Top quality pipework? That's where Lawrie's step in. For many years we have been producing fabricated pipework to B.S. and A.P.I. standards, our welding is approved by Lloyd's and other inspecting authorities, and we are on the approved list of pipework contractors to the U.K. Atomic Energy Authority.

PUT YOUR PIPEWORK PROBLEMS TO LAWRIE

J. & T. LAWRIE LIMITED · LIVINGSTONE STREET · CLYDEBANK · SCOTLAND *Tel: Clydebank 2171/2/3*
and associate company William Wilson & Sons (Port Glasgow) Ltd., East Bay Industrial Estate · Port Glasgow. *Telephone: 41050.*

London Office: 34 Victoria Street, London, S.W.1. *Telephones: ABBey 4937 and 1847.*

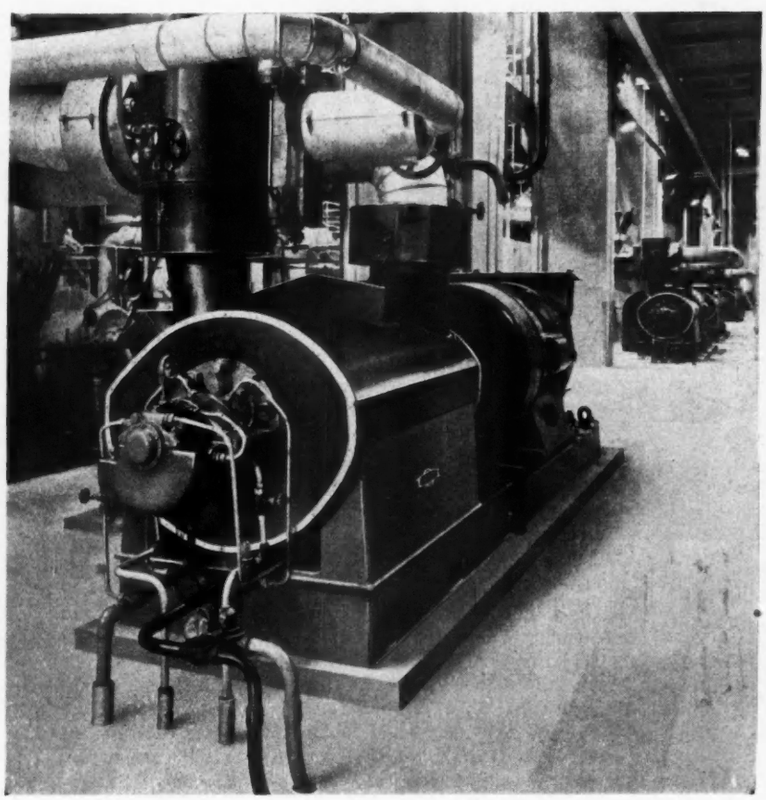
The largest concentration of power in Europe-Hams Hall "A," "B" & "C" Birmingham

Hams Hall "C," Birmingham, is equipped with

12

Weir

BOILER FEED PUMPS



Weir Electrofeeders in Hams Hall "C" Power Station

Each of the twelve Weir Electrofeeders in the Central Electricity Generating Board's "C" Station at Hams Hall has a capacity of 650,000 lb./hr. at 1,210 lb./sq. in. with a suction temperature of 277°F.

Weir Turbine-Driven pumps are also in use in the "A" and "B" stations at Hams Hall.

G. & J. Weir Ltd.

CATHCART · GLASGOW, S.4.

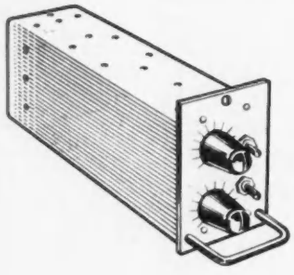
A.W.A ELECTRONICS

New concepts in electronics have been developed at A.W.A, as a result of experience with missile systems. Now they have a wider application. Here are some of the new A.W.A devices now available to industry.

U.H.F. WIDEBAND RECEIVER

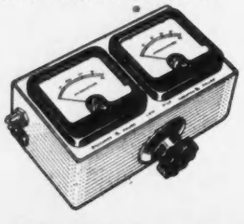
Basic arrangement consists of R.F. amplifier, mixer, local oscillator, I.F. amplifier (A.G.C. controlled), cathode follower output stage. Tuning indicator (EM 34) is also fitted to receiver. The standard forms: one for airborne racking with special separate power supply unit, the other on larger chassis including power supply unit (conventional 19" front panel). *Standard specification: 420-470 M/cs frequency range; 4 M/cs overall bandwidth, approximately 10 db noise factor; approximately 70 ohms input impedance. 200-250 V and 50-60 c/s input supply. Input is unbalanced, output is via low impedance (cathode follower) stage.*

TRANSISTOR GALVANOMETER AMPLIFIER

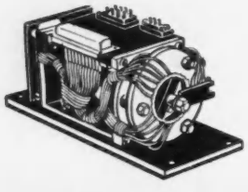


This amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attenuator at its input and will accept single ended or push-pull signals from ± 1 Millivolt to ± 500 volts and will feed a maximum of ± 50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.; Frequency response: Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: 10 Microvolts at either input; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 5 Milliamps/Millivolt, minimum 0.04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

DIRECTIONAL COUPLER



Of the 'Loop' type, suitable for measurements of RF power and Standing Wave Ratio in coaxial cables. Directional properties are largely unaffected by frequency changes, so coupler may be used to help obtain optimum termination of a 52 ohm coaxial system up to 600 M/cs. *Standard Specification: Size 7" x 4" x 2¾"; weighs 4 lbs. 3 ozs.; Power Measurement Range is Low range 1 w.cw.max. High range 5 w.cw.max.; less than 1% attenuation; better than 2% accuracy at frequency of calibration.*



ROTARY SWITCH FOR TELEMETRY

Based on a conception of British Ministry of Supply's Research and Development Establishment, gives facilities previously unobtainable from mechanical sampling devices. The Standard Model enables two 24 channel banks to be sampled at speeds up to 200 r.p.s.

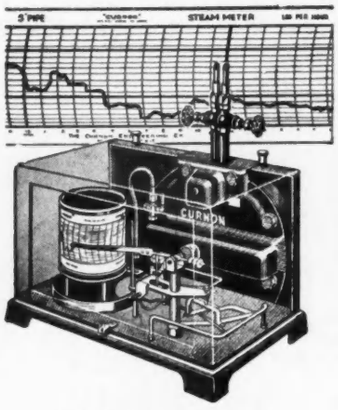
All devices are adaptable to suit customers' own requirements. For further information consult:

A.W.A ELECTRONICS

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD. / Baginton, Coventry.

MEMBER OF THE HAWKER SIDDELEY GROUP

"IF YOU CAN MEASURE STEAM—
—YOU CAN MEASURE WASTE"
with the
"CURNON"
STEAM METER



- 24-HOUR GRAPH RECORDS
- EASY INSTALLATION
- AUTOMATIC PRESSURE COMPENSATION
- ENTIRELY MECHANICAL
- INTEGRATOR CAN BE PROVIDED
- CAN BE FITTED ABOVE OR BELOW PIPES

DON'T LET PROFITS GO UP IN STEAM!
FULL DETAILS ON APPLICATION

CURNON ENGINEERING CO.
CLAUDE ROAD WORKS, CHORLTON, MANCHESTER, 21

WELDED STEEL PLATEWORK
In ¼" to ½" thick Mild Steel

PRESSURE VESSELS
TANKS & CYLINDERS
CHIMNEYS
DRYERS
HOPPERS
CYCLONES
BEDPLATES
ANGLE & FLAT BAR RINGS

C&M. ENGINEERING CO. LTD.

THAMES Rd. BARKING, ESSEX
TELEPHONE: RIPpleway 3011-2

ROYAL SHOW

OXFORD
JULY 7th to 10th, 1959
Exhibition of Implements, etc.
The Regulations and Provisional Forms of Application for Space are now ready
ENTRIES CLOSE
MONDAY, NOV. 24th, 1958
ENTRIES FOR SILVER MEDAL
close Monday, January 19th, 1959
LIVESTOCK PRIZE LISTS
will be ready for issue during February, 1959
ALEC HOBSON, Secretary,
Royal Agricultural Society of England
35 Belgrave Square, London, S.W.1

G·G·L

We all know this man. He's the chap who has just tried GGL for the first time and can't stop talking about the wonderful quality and service. He's a nice man, really, but he does go on . . . and it isn't as if we old stagers didn't rely on GGL service, too.

CAPSTAN AND AUTOMATIC WORK AND SHEET METAL PRESSING IN ANY METAL, ANY FINISH, ANY QUANTITY

FOR QUICK SERVICE AT THE RIGHT PRICE GET IN TOUCH WITH:
GRIFFITHS, GILBART, LLOYD & CO. LTD.
EMPIRE WORKS, PARK ROAD, BIRMINGHAM, 18
TEL: NORTHERN 6221

FLEXFLYTE

LIGHTWEIGHT DUCTING
for extremes of PRESSURE & TEMPERATURE

Where a sinuously flexible ducting, light in weight and of great tensile strength is an operating necessity . . . specify Flexflyte. It has been time-tested under the most exacting conditions. Combined with a high resistance to abrasion, Flexflyte can handle a wide range of

PRESSURES — Internal — up to 70 psig; External — up to 15 psig
&
TEMPERATURES — From minus 120 Fahrenheit To plus 650 Fahrenheit

Toughly built with a spring steel wire helix, Flexflyte is available in a variety of standard diameters, coverings and linings. It can also be "tailored" to specific requirements. An illustrated technical brochure gives you all the details. Send for your copy today.

LIGHT
TOUGH
HEAT RESISTANT
FLEXIBLE

ANOTHER PRODUCT BY THE MANUFACTURERS OF SPIRATUBE
FLEXIBLE DUCTING LIMITED
103, SHUNA STREET, MARYHILL, GLASGOW, N.W.
Telephone: MARyhill 3729 Telegrams: FLEXIDUCT, GLASGOW, N.W.
An associate company of George MacLellan & Co., Ltd., Established 1870.

STEEL

KEY TO INDUSTRY

No. 31

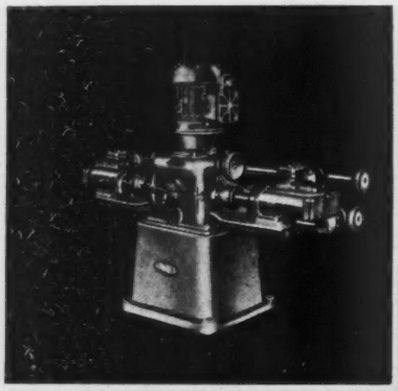
We do know that the development of steel
made possible the growth of
civilisation itself. For steel is the key to
the good things of life
as well as to the necessities;
as essential to the maker of
the precision watch as to the bridge builder.
Hallamshire high-grade Alloy and Carbon steels
serve a multitude of industries in many ways.

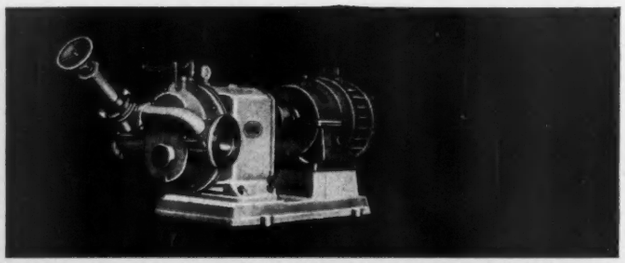
St. Mary's Church, Eaton Bray, Bedfordshire, is rich with superb work of the 13th Century. But it is the ironwork for which the lover of beauty seeks out this place. One of the master smiths of the 13th Century, Thomas of Leighton, gave its door three hinges on which is some of the most perfect scroll of his time. This key fits an old oak chest found in St. Mary's. Is the key to Thomas of Leighton's door still in existence?

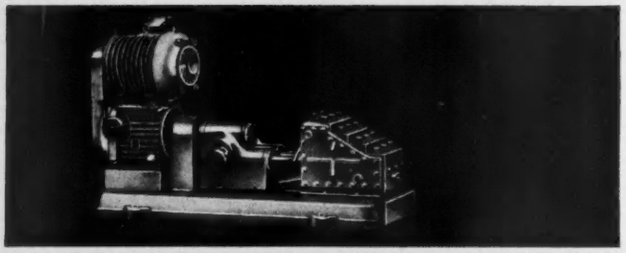
Hallamsteel

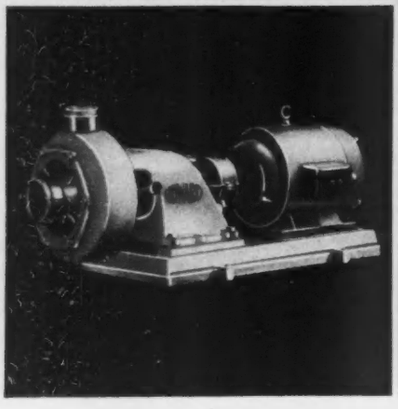
Manufacturers of:
ALLOY AND SPECIAL CARBON STEELS
BARS · SHEETS · PLATES · WIRE RODS

THE HALLAMSHIRE STEEL COMPANY LIMITED
SHEFFIELD 3, ENGLAND
Telephone: Sheffield 24304 (7 lines) · Telegrams: Hallamsteel, Sheffield









WHAT ARE YOUR SPECIAL NEEDS?

Must resist corrosion — Could be steam-jacketed?
Robust construction — Handle high V.I. material
Economical running — Simple maintenance & cleaning

Whatever they are we may be able to help

Howard

For further information, please write to:—
HOWARD PNEUMATIC ENGINEERING CO. LTD.,
FORT ROAD, EASTBOURNE. TEL: EASTBOURNE 1179
TELEGRAMS AND CABLES: HOWMATIC, EASTBOURNE

HOWARD PUMPS are good pumps: carefully designed and solidly constructed to precise specifications. Even more important than this, however, every Howard Pump has been designed to do some special job and to do it in the most efficient and economical manner. While our standard models cover a very wide range, we fully appreciate the need for unusual materials and designs, and are always happy to receive enquiries based on special problems.

HOWARD 'M' TYPE ALL STAINLESS STEEL POSITIVE ROTARY PUMP
Handles delicate materials—even those with high V.I.—without agitation or contamination. Designed for easy stripping and cleaning. Seven sizes offering up to 15,000 g.p.h. for heads up to 200 ft.

HOWARD CENTRIFUGAL PUMP
Single stage, high pressure pump with circular casing, external heavy duty bearings. Two basic models—FOR CHEMICALS: a normal centrifugal pump with closed impeller and flanged connections.
For FOOD: internal parts machined all over and specially arranged for easy cleaning. Capacities range up to 250 g.p.m. for heads up to 140 p.s.i.

HOWARD TRIPLEX PUMP
A fixed-capacity pump designed to offer a smooth and pulseless flow against high pressures. Special liquid ends can be fitted if required. Three motor sizes (5, 10, and 20 h.p.) afford a maximum capacity of 6,000 g.p.h. for pressures up to 2,000 p.s.i.

HOWARD PROPORTIOMETER PUMP*
A robustly constructed variable output plunger pump. The simple control device permits adjustment from zero to maximum output while the pump is running or stationary. Eight sizes offering a maximum capacity of 2,000 g.p.h. and pressures of up to 12,000 p.s.i. Can also be arranged for remote automatic control if required.

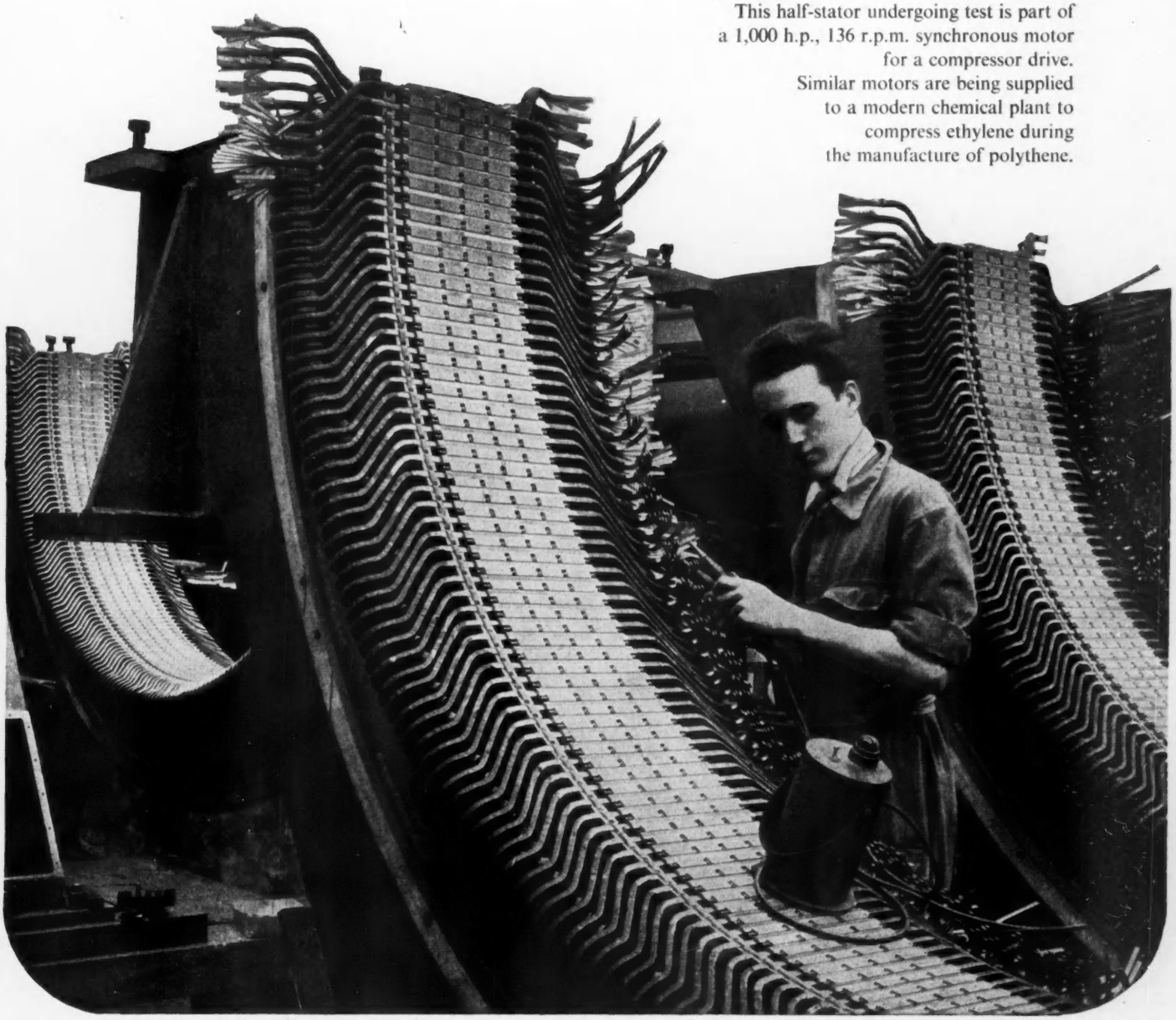
ALL HOWARD PUMPS can be made in Stainless Steel or other corrosion-resisting materials, such as bronze, aluminium, Lang Alloy 4R, 5R, 6R or 7R and any other machinable material. They can also be jacketed for heating or cooling.

**Made under Moore & Charlton Patents No. 476553 & 500569*

'ENGLISH ELECTRIC'

drives for the chemical industry

The ENGLISH ELECTRIC Company designs and manufactures a wide range of drives for general or special applications in the chemical industry. This half-stator undergoing test is part of a 1,000 h.p., 136 r.p.m. synchronous motor for a compressor drive. Similar motors are being supplied to a modern chemical plant to compress ethylene during the manufacture of polythene.



THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Electrical Plant Sales, Stafford

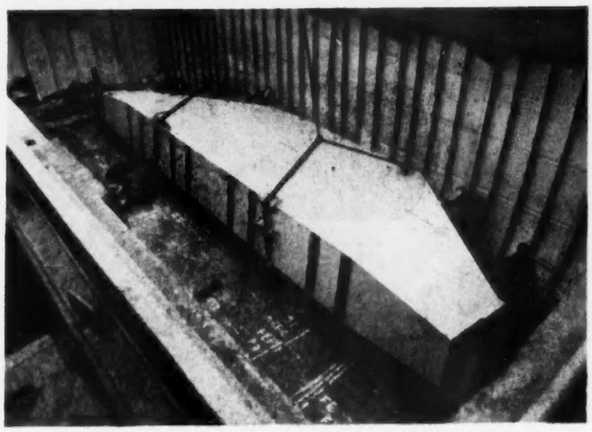
PS. 32E8 WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

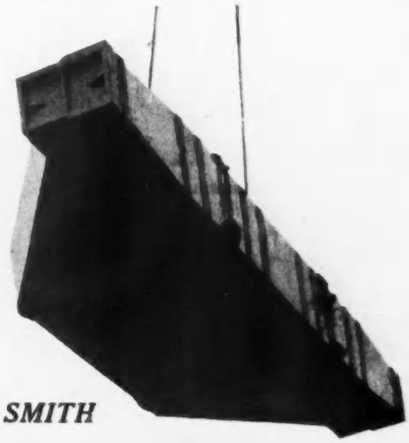
Send now for these G.E.C. publications

'Smoke is your problem' (publications No. OV3865 and OV4393) describe—in detail—the G.E.C. Photoelectric Smoke Density Measuring Equipments. Designed in the interest of smoke abatement, these devices give an immediate and accurate check of the smoke density in a stack.

THE GENERAL ELECTRIC CO. LTD · MAGNET HOUSE · KINGSWAY · LONDON W.C.2

nothing too BIG or too HEAVY

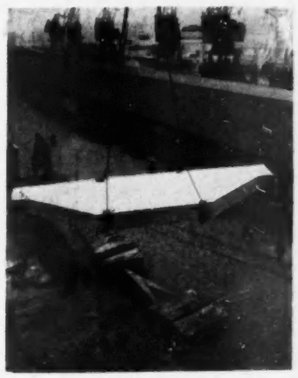




for the ARBUCKLE, SMITH

SHIPPING AND FORWARDING SERVICE...

No matter how cumbersome or awkward your consignment may seem you can safely entrust it to an organization like ours which successfully handles the toughest assignment to any part of the world as a matter of normal routine



Arbuckle, Smith & COMPANY, LIMITED

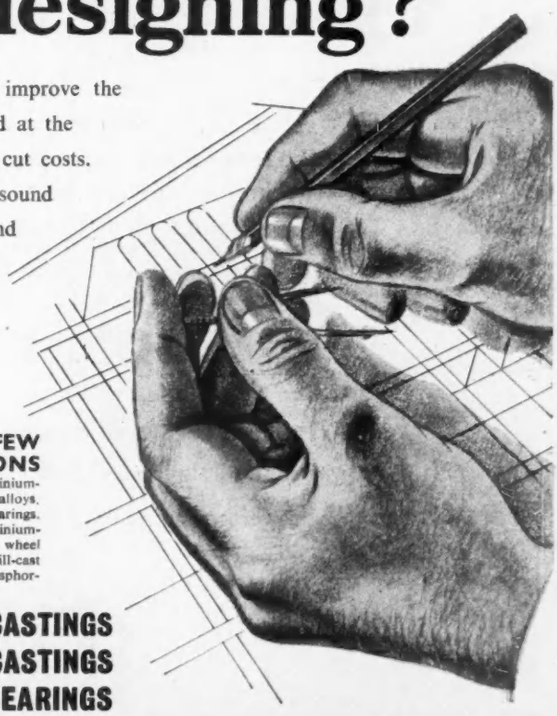
91 MITCHELL STREET, GLASGOW, C.1.

Telephone: City 7080 (20 lines) *Grams:* ARBOR, GLASGOW

and at: LONDON, LIVERPOOL, SOUTHAMPTON, HULL, DUBLIN, MANCHESTER, NEWCASTLE, TORONTO, MONTREAL, WINNIPEG, VANCOUVER AND LAGOS

ARE YOU re-designing?

Very often our design engineers can improve the structural form of your castings, and at the same time reduce complexity and cut costs. That way you'll get cheaper, more sound casting of unequalled quality and accuracy. This technical teamwork can tackle *all* your casting problems —and *solve* them.



BIRSO TRADE MARK BN

CASTINGS FROM A FEW OUNCES TO 10 TONS

in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze, and light alloys. Precision machined bushes and bearings. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, shell moulded castings, and chill-cast rods and tubes. Continuous cast phosphor-bronze bars up to 12 feet lengths.

NON-FERROUS CASTINGS
HIGH-DUTY IRON CASTINGS
PRECISION MACHINED BUSHES AND BEARINGS

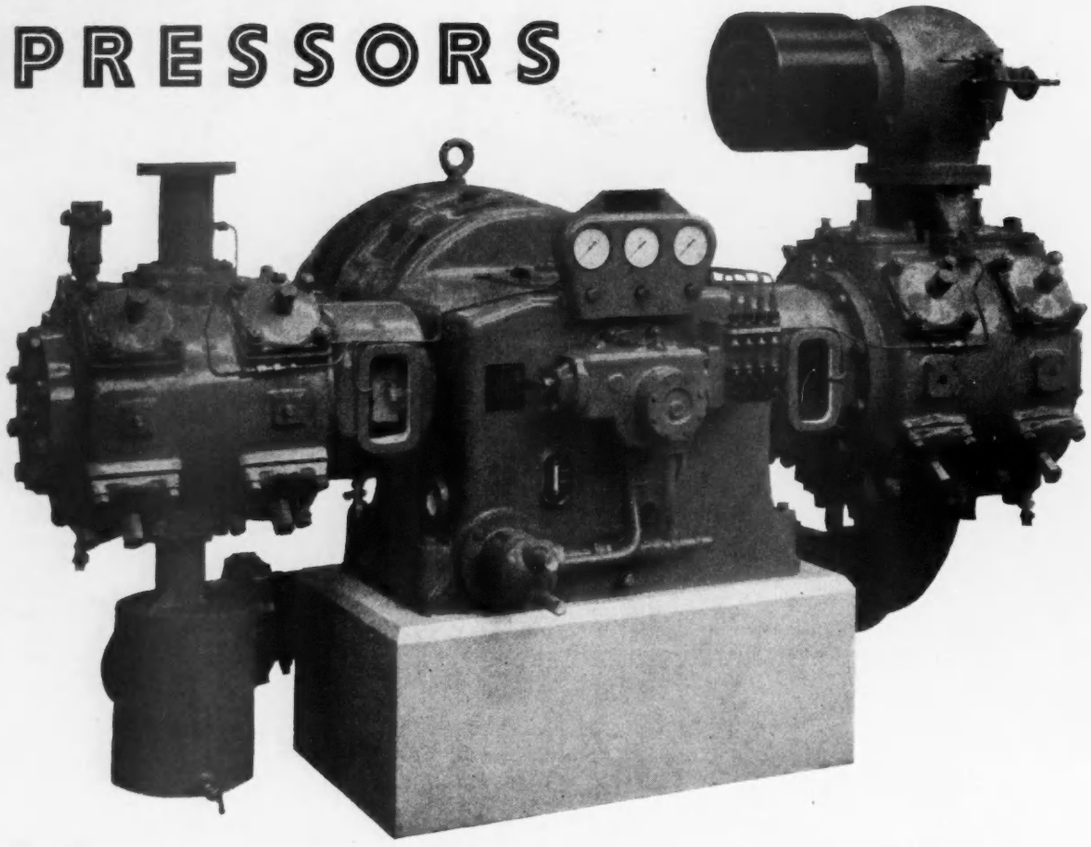
T. M. BIRKETT, BILLINGTON & NEWTON LTD

HANLEY AND LONGPORT, STOKE-ON-TRENT, ENGLAND

Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5/6/7. LONGPORT, Phone: Stoke-on-Trent 87303

ALLEY

BALANCED OPPOSED COMPRESSORS



The long established high quality of Alley Compressors is combined in these machines with the known advantages of the horizontally-opposed design.

COMPACTNESS: Intercooler lies below motor. Motor is built on.

BALANCE: No horizontal or vertical out-of-balance forces.

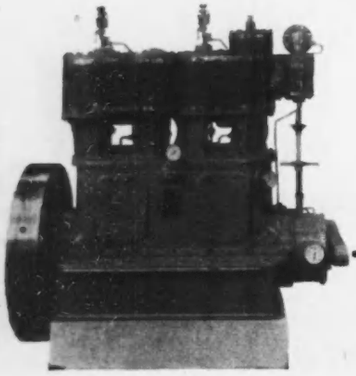
FREEDOM FROM VIBRATION

Can be installed on a minimum foundation—even on an upper floor.

The unit is complete—intercooler and oilcooler incorporated—ready for bolting down.

Range of single and two stage machines up to 10,000 c.f.m.

A corresponding range of VACUUM PUMPS is available with displacements up to 12,000 c.f.m.

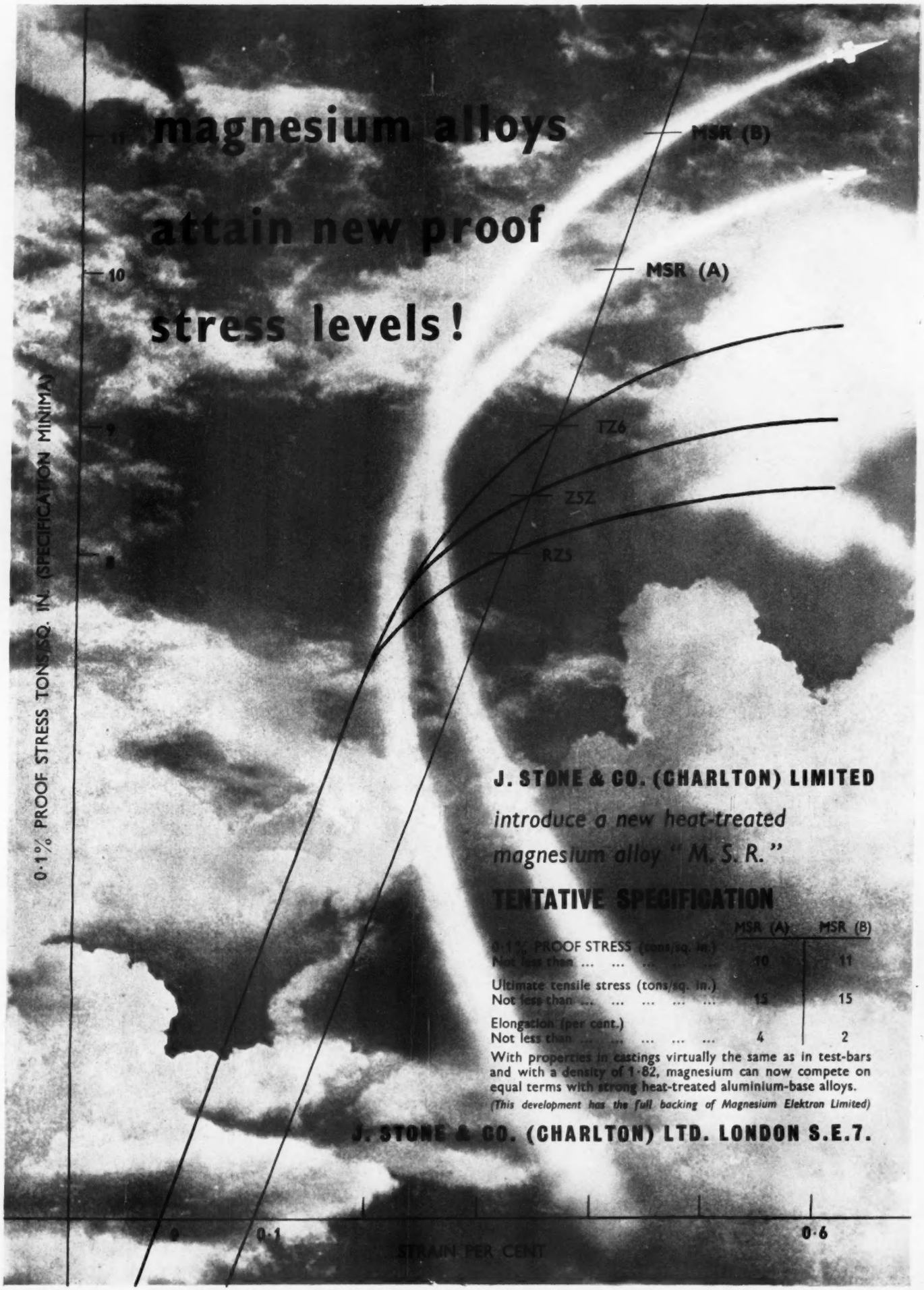


ALLEY & MACLELLAN (POLMADIE) LTD.,

GLASGOW, S.2.

Licensed to manufacture Gas Compressors to the designs of Clark Bros. Co., Olean, U.S.A.

THE ALLEY B/L STEAM ENGINE: A high class range of single and two cylinder engines of compound and non-compound type, with outputs ranging from 40 B.H.P. to 750 B.H.P.



J. STONE & CO. (CHARLTON) LIMITED

introduce a new heat-treated magnesium alloy "M. S. R."

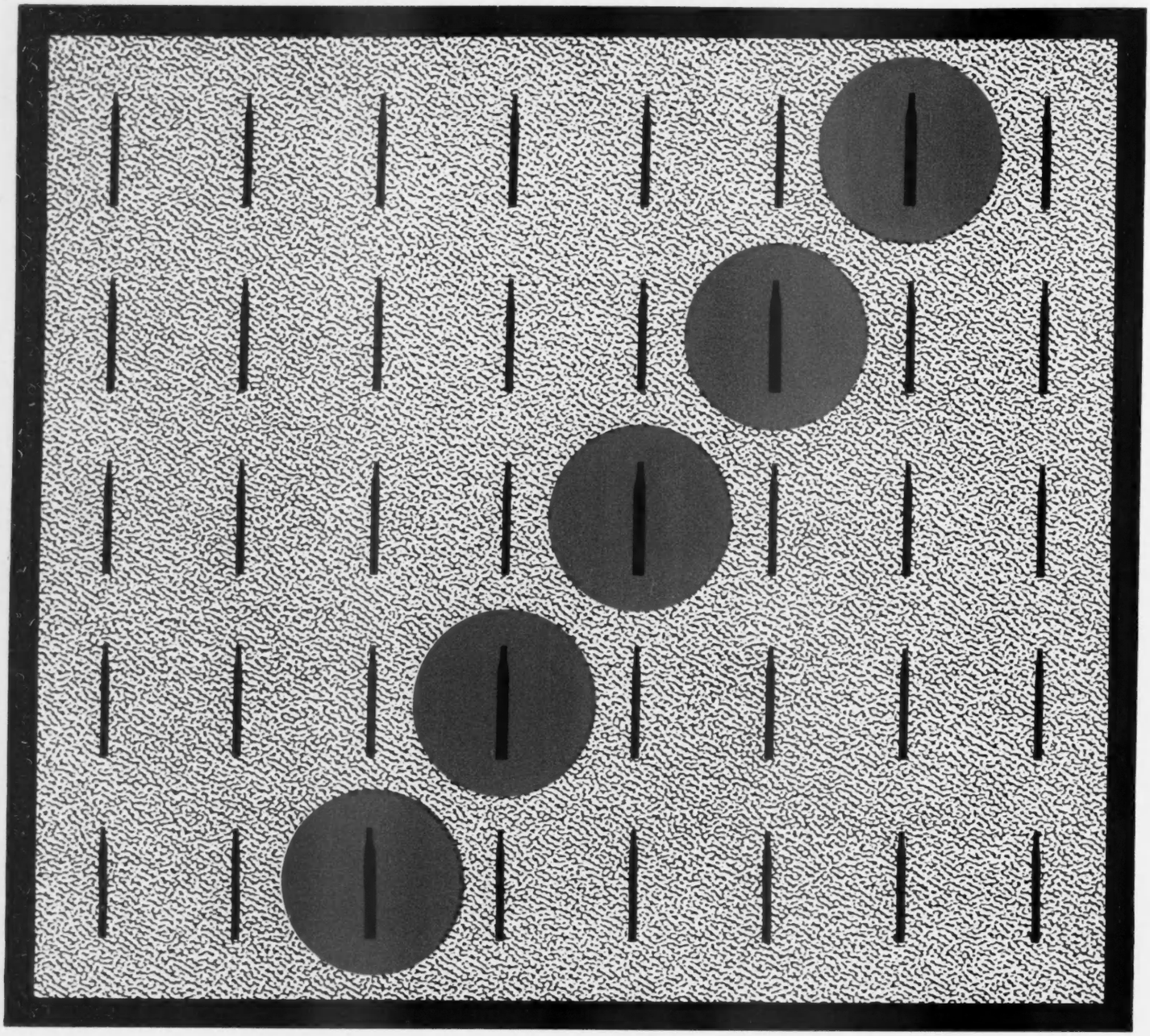
TENTATIVE SPECIFICATION

	MSR (A)	MSR (B)
0·1% PROOF STRESS (tons/sq. in.) Not less than	10	11
Ultimate tensile stress (tons/sq. in.) Not less than	15	15
Elongation (per cent.) Not less than	4	2

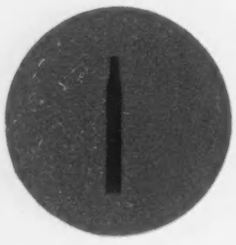
With properties in castings virtually the same as in test-bars and with a density of 1·82, magnesium can now compete on equal terms with strong heat-treated aluminium-base alloys.

(This development has the full backing of Magnesium Elektron Limited)

J. STONE & CO. (CHARLTON) LTD. LONDON S.E.7.



5 Quasi-Arc iron-powder electrodes for increased welding productivity



This unrivalled range of Quasi-Arc iron-powder electrodes sets new standards in welding production, quality and economy. All these electrodes give faster welding, high quality weld metal, even easier slag removal.

FERROMAX—unique combination of a rutile covered electrode depositing low-hydrogen weld metal. High currents give increased welding speeds, yet excellent mechanical properties are maintained.

FERRON (New Type)—a basic low-hydrogen electrode for all-position welding, especially on heavy sections or restrained joints.

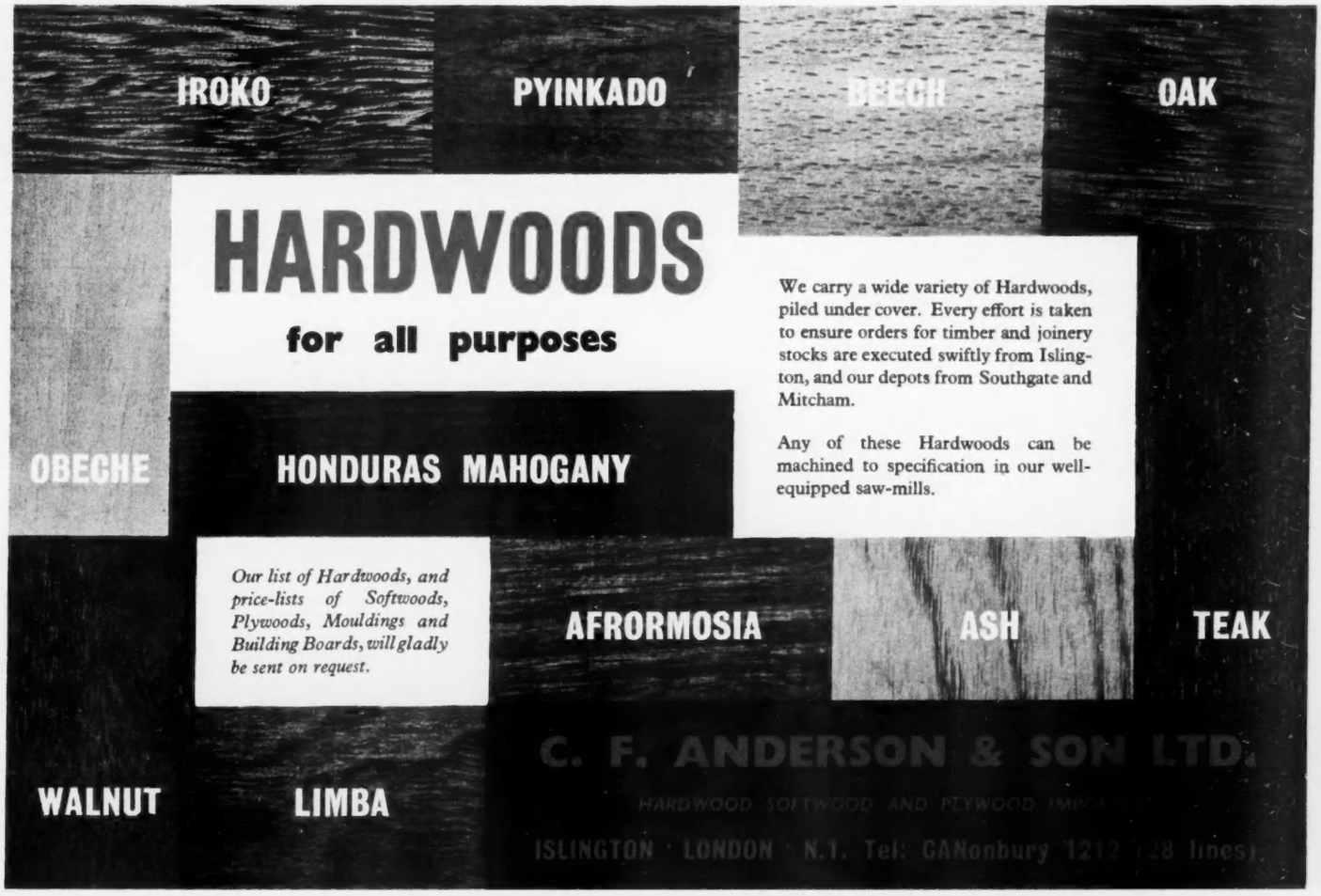
PRESSURE VESSEL (New Type)—for welding thick-walled vessels in the flat position to high radiographic standards.

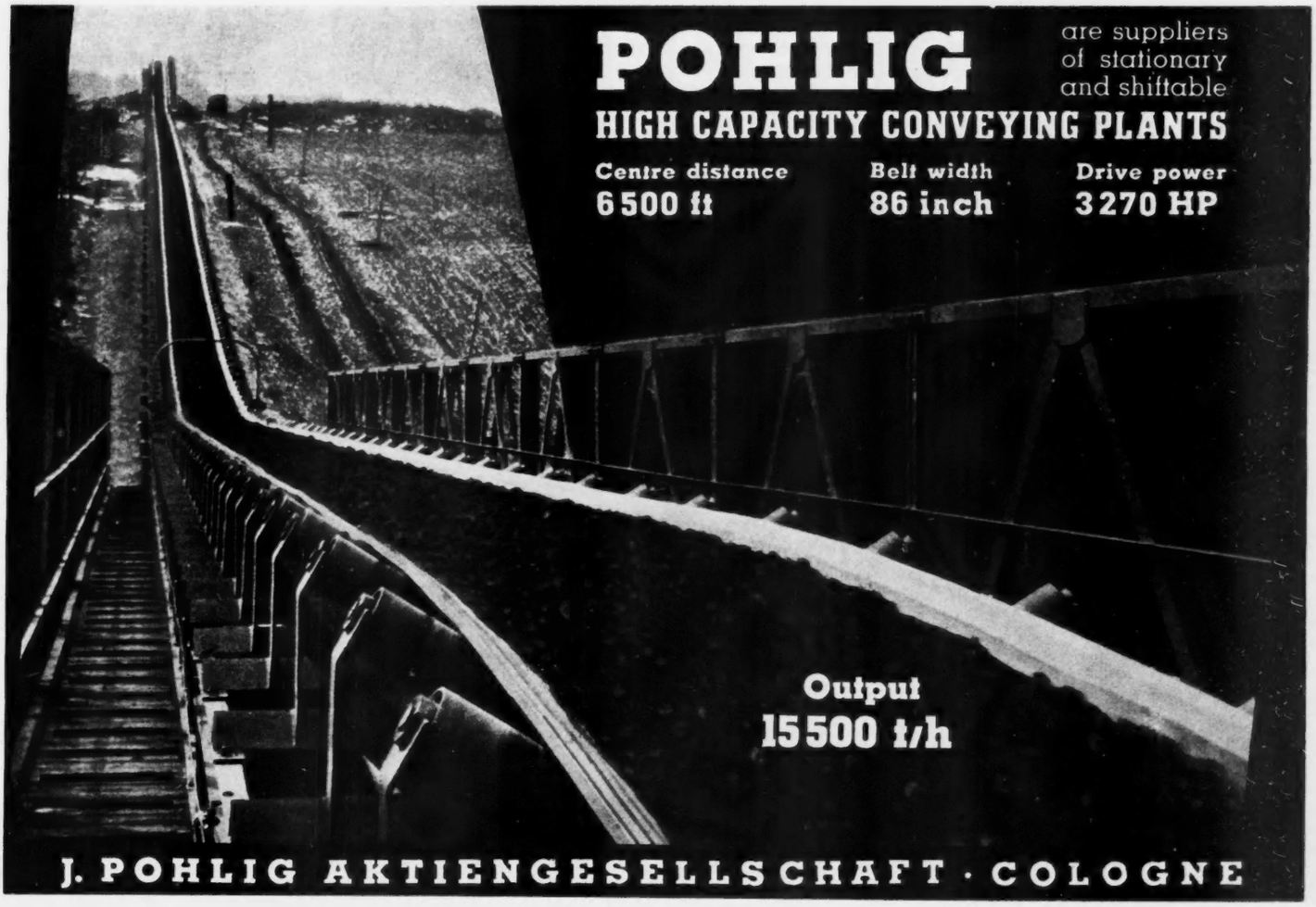
CELTIAN—with a cellulose type of covering, has special applications in the oil industry. Designed for "stovepipe" welding and for vertical downwards butt welding on oil storage tanks.

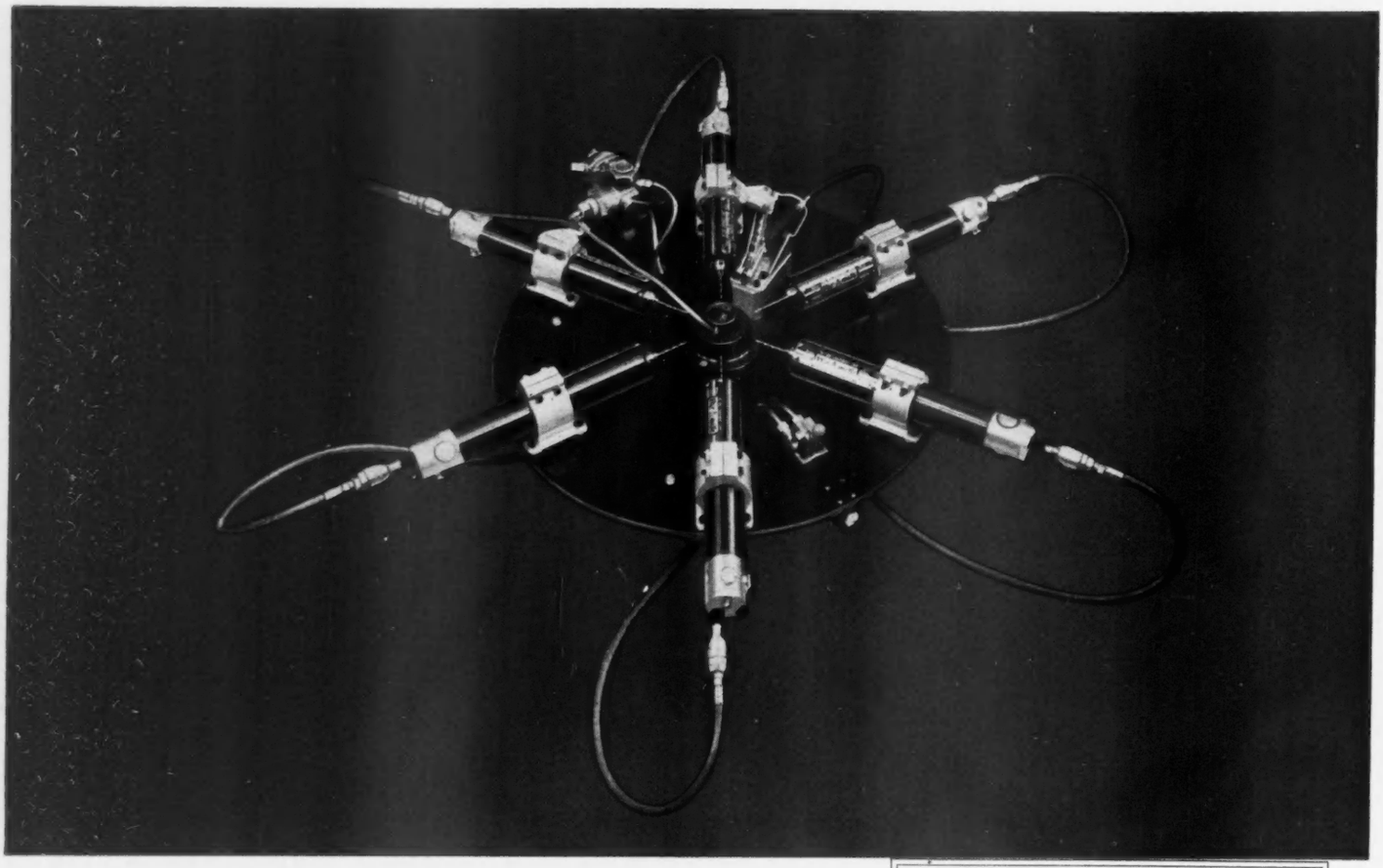
FERROLUX—the latest addition to the range, especially suitable for the mass production of general engineering components.

Quasi-Arc ***world leaders in arc welding***

Quasi-Arc Limited, Bilston, Staffordshire


IROKO
PYINKADO
BEECH
OAK
HARDWOODS
for all purposes
We carry a wide variety of Hardwoods, piled under cover. Every effort is taken to ensure orders for timber and joinery stocks are executed swiftly from Islington, and our depots from Southgate and Mitcham.
Any of these Hardwoods can be machined to specification in our well-equipped saw-mills.
OBECHE
HONDURAS MAHOGANY
Our list of Hardwoods, and price-lists of Softwoods, Plywoods, Mouldings and Building Boards, will gladly be sent on request.
AFRORMOSIA
ASH
TEAK
WALNUT
LIMBA
C. F. ANDERSON & SON LTD.
HARDWOOD SOFTWOOD AND PLYWOOD IMPO
ISLINGTON · LONDON · N.1. Tel: CANonbury 1212 (28 lines)


POHLIG
are suppliers of stationary and shiftable
HIGH CAPACITY CONVEYING PLANTS
Centre distance
6500 ft
Belt width
86 inch
Drive power
3270 HP
Output
15500 t/h
J. POHLIG AKTIENGESELLSCHAFT · COLOGNE



Drilling 6 holes at a time in a compressor piston, increasing production and reducing costs.

"ARO-BROOMWADE" PAR-A-MATICS

Save Man - hours

Par-A-Matics are compact, self-feed pneumatic tools designed for multiple drilling, burring, tapping, grinding, reaming, nut-running, positioning . . . almost any operation requiring rotating tools which can be accommodated in a ¼in. or 5/16in. chuck.

QUICKLY ADAPTED TO CHANGING NEEDS

Par-A-Matics are invaluable for long or short production runs. Gears are interchangeable for speedy conversion to any of seven speeds from 500 to 17,000 r.p.m. You can easily mount Par-A-Matics at any angle for automatic or semi-automatic operation. You can link any number for simultaneous functioning. One man, using a remote control valve, can operate a whole battery of Par-A-Matics.

Par-A-Matics really *will* SAVE YOU MONEY. Expert technical advisers are available for guidance on schematic layouts, based on a wide experience in the application of Par-A-Matics. Ask for Publication No. 443 T.E.

"BROOMWADE"

Air Compressors and Pneumatic Tools

YOUR BEST INVESTMENT

BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND

Telephone : High Wycombe 1630 (10 lines) Telegrams : " Broom ", High Wycombe. (Telex.)

602 SAS

THE VERSATILITY OF PAR-A-MATICS covers almost any kind of rotating tool

VISIT OUR STAND

Public Works & Municipal Services Exhibition, Olympia.

10-15 November, 1958.

Stand 28.

GRAND HALL.

„Russ" Electric Furnaces = A Maximum of Economy and Reliability

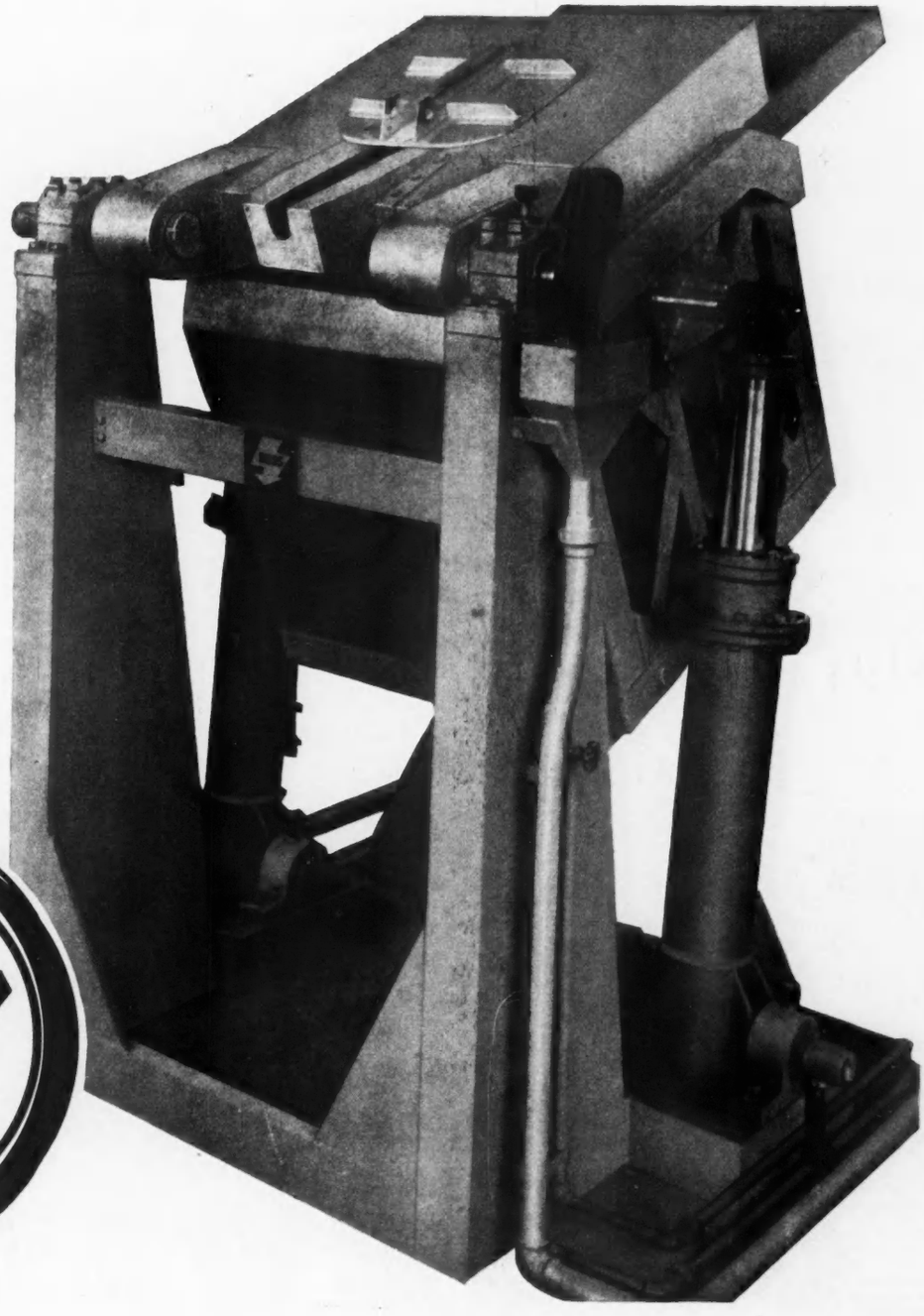
Mains Frequency Coreless Induction Furnace

for melting steel and cast iron

Capacity: 1100 lbs
Melting rate: 550 lbs/h at 1600° C tapping temperature

RUSS-ELEKTROOFEN KG · COLOGNE

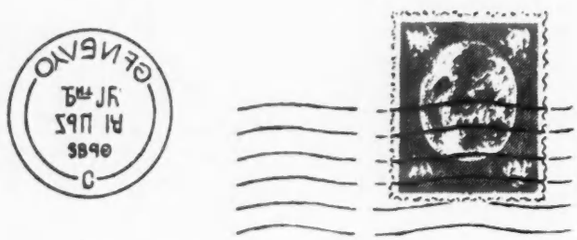
RUSS-ELECTRIC FURNACES S.A. (Pty.) Ltd.
P. O. Box 613 · Springs, Transvaal · South-Africa



RUSS

Address your enquiries about gearing to NEWBURY*

*the home of Opperman Gears



Opperman Gears Limited,
NEWBURY,
Berkshire.

For prompt and efficient attention to your enquiries for all types of Geared Motors, Gears and Reduction Gear Units, please ensure they are addressed to

OPPERMANS OF NEWBURY

OPPERMAN GEARS LTD, NEWBURY, BERKSHIRE. Telephone: Newbury 1701. Telegrams: Oppigears, Newbury.

Serving Britains Industry

GRIFFIN BRAND

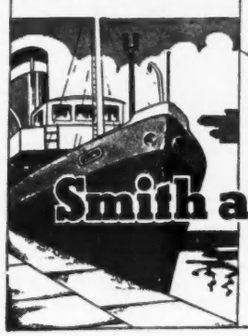
STEEL SHEETS

★ Light and Heavy industry are served by Griffin Brand Steel Sheets—Black, Galvanised, Flat and Corrugated.

★ We make the widest steel sheets and have the largest general galvanising plant in Great Britain.

★ Metal Spraying by the most up-to-date methods done in our works or 'in situ'.

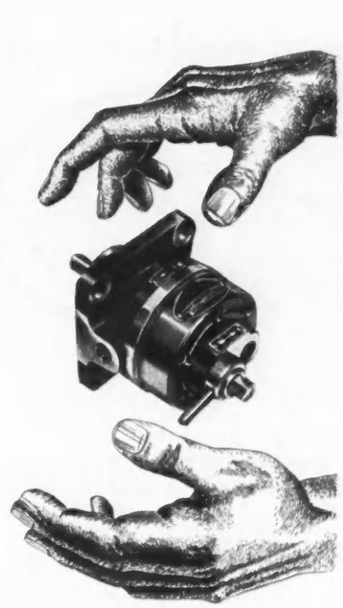
Metals deposited include: Zinc, Tin, Aluminium, Copper and all its alloys, Cadmium, Monel Metal, etc.



Smith and McLean Ltd.

179 WEST GEORGE STREET
GLASGOW, C.2.

Tel: CENtral 0442. 'Grams: "CIVILITY Glasgow."



More accurate than human skill itself

Hydraulic Control of motion

Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

FOR FURTHER DETAILS OF

SAVERY HYDRAULIC PUMPS

WRITE TO

THOMAS SAVERY PUMPS LIMITED

BRACEBRIDGE STREET, BIRMINGHAM 6 : Telephone: ASTon Cross 1316-7

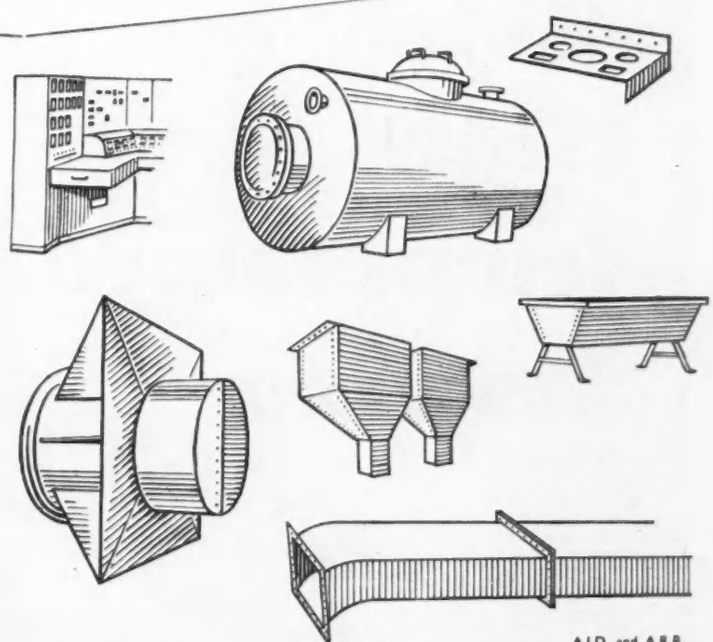
EVERYTHING IN SHEET METAL WORK
GENERAL ENGINEERING

Consult

V. W. CO., LTD.

FOR FABRICATION and GENERAL ENGINEERING

General Sheet Metal Work, Metal Pressing and Stamping, Duct Work and Ventilating Plants, Tanks Cylinders Turning Milling etc. PLATING, Chrome, Nickel, Cadmium etc.

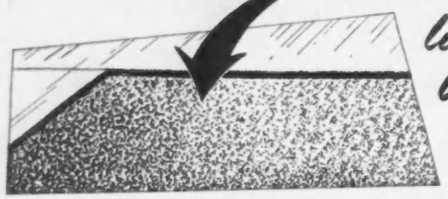


A.I.D. and A.R.B. approved

V. W. CO., LTD.

Radspray Works, High Street, Stratford, London, E.15 Tel: MARyland 6761 (6 lines)
Also at: EASTERN INDUSTRIAL ESTATE, HARLOW, ESSEX Tel: 24721

The KEY to a good replacement floor topping



lies just below the surface!

—a mechanically prepared existing sub-surface

by the METTEXTURE PROCESS

Superseding slow and inefficient methods of hand hacking.

Saving time and materials.

Minimising interruption to factory routine and road traffic.

The METTEXTURE SERVICE includes EQUIPMENT and OPERATORS

It PAYS to know about The Metterture Process

THE METROPOLITAN CONSTRUCTION CO LTD

GREENWICH HOUSE. 11, NEWGATE ST., LONDON, E.C.1. Tel. City 1488

The Nitriding Process for Case-hardening Special Steels by Nitrogen offers

- Surface hardness up to 1100 D.P.H.
- Retention of full hardness after heating to 500°C.
- Maximum resistance to frictional wear and fatigue.
- Improved resistance to corrosion by water and steam.

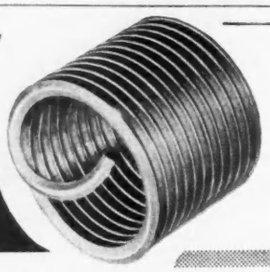
Particulars from:—

NITRALLOY LIMITED

ATLAS WORKS SHEFFIELD, 4.

Telephone: Sheffield 26646 Telegrams: "NITRALLOY, SHEFFIELD."

Better than New with a . . . .

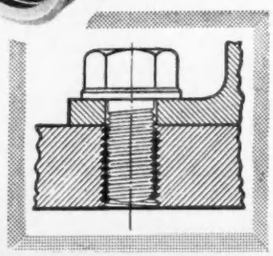


Cross

BRITISH WIRE THREAD INSERT

PRECISION MADE in CARBON STEEL for ALUMINIUM and MAGNESIUM.

We also make Stainless and Bronze for other applications.



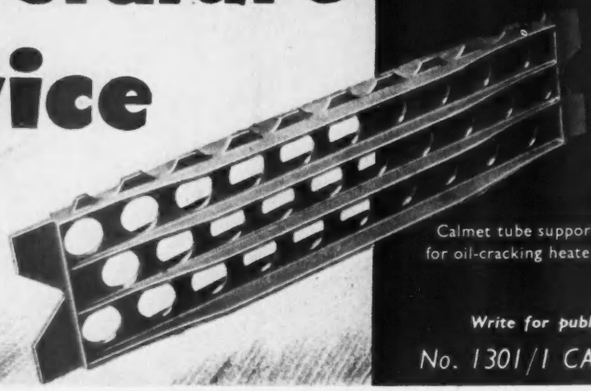
CROSS MANUFACTURING CO. (1938) LTD.

Tel: Combe Down 2355-8 BATH, SOMERSET *Grams: Circle, Bath*

Specialists in JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS, etc.

Metals for High Temperature Service

Calorized Mild Steel recuperator tubes and plates



Calmet tube support for oil-cracking heater

CALORIZING

PROTECTS MILD STEEL AND CAST STEEL AGAINST OXIDATION AT HIGH TEMPERATURE

CALORIZED pots and boxes for salt and cyanide hardening · carburising · case hardening · annealing · melting pots for lead and magnesium thermo-couple tubes · recuperator tubes · etc.

CALMET

HEAT RESISTING ALLOY STEEL CASTINGS

for oil-cracking tube supports, hangers, baffles and beams. Superheater supports and slings. Furnace & boiler components, etc.

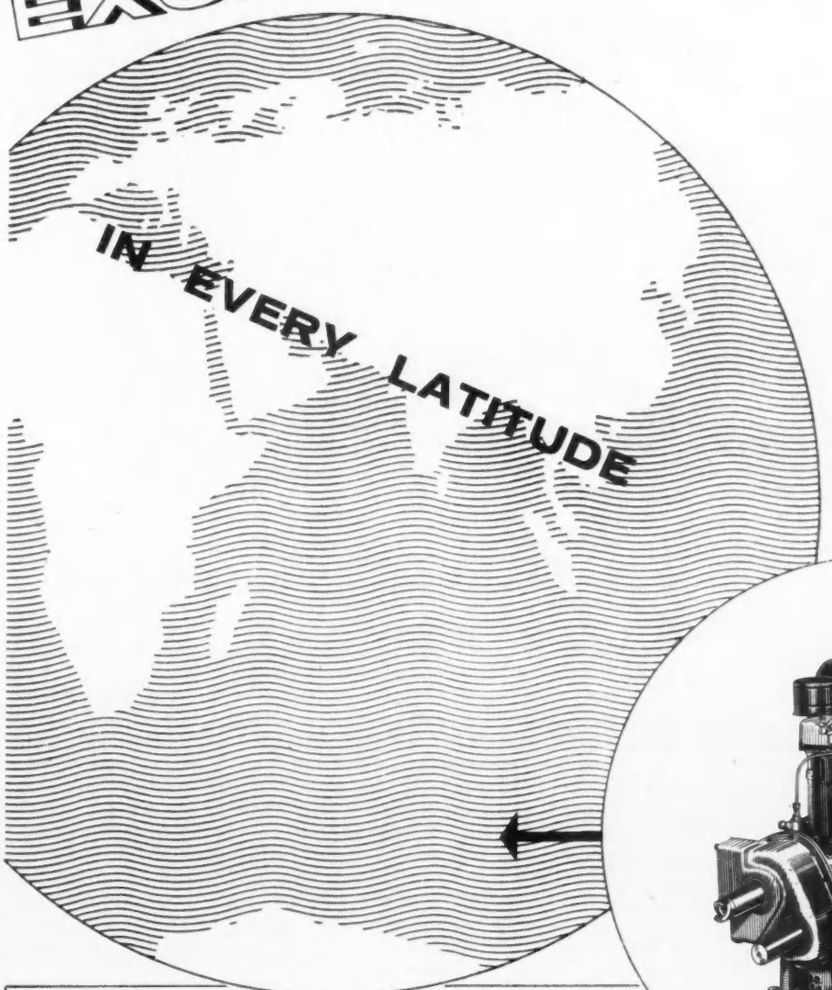
Write for publications:

No. 1301/1 CALORIZING *No. 1638 CALMET*

THE CALORIZING CORPORATION OF GREAT BRITAIN LTD

LYNTON HOUSE, 7/12 TAVISTOCK SQUARE, LONDON, W.C.1. Telephone: EUSton 4321

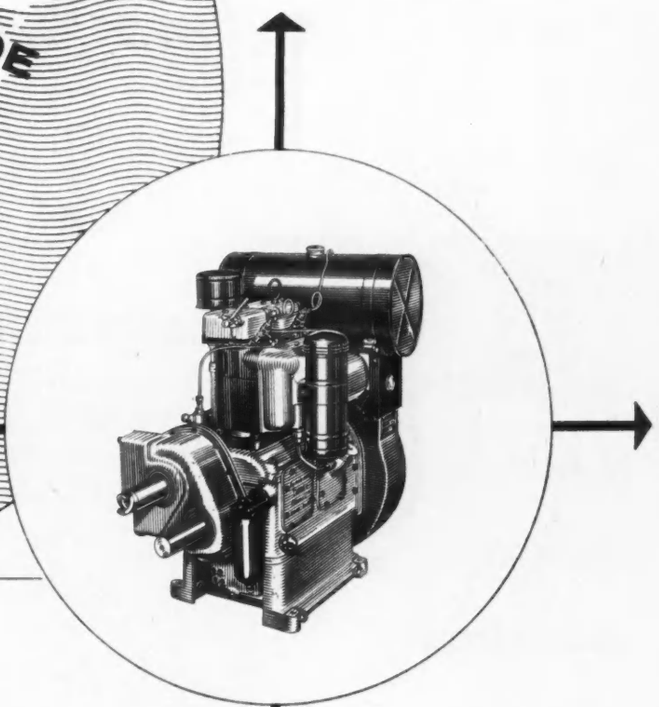
EXCEPTIONAL SERVICE



"10,000 Hours—No Repairs"
"The engine has been running a Mortar Mill 40 hours a week for five years; during that time there were never any repairs done, in fact the head was never off."
John McMillan & Son, Whitehouse, N. Ireland.

"Amazed at their Reliability"
"I have six of the 6-11 h.p. Armstrong Siddeley Air-Cooled engines; I must say I am more than satisfied with the engines and amazed at their reliability taking into account the very dusty air, sandstorms, and a temperature of around 123°F."
K. R. Gregory, Qatar, Persian Gulf.

"Done a Wonderful Job"
"The Armstrong Siddeley Air-Cooled engine has done a wonderful job; one set of rings and two valve grinds, and still uses no oil between changes."
V. Altman, Victoria, Australia.



YEARS OF KNOW-HOW: The diesel engines are manufactured with the same precision as the world-famous Armstrong Siddeley aero engines.

MATERIAL-CHECKED: Armstrong Siddeley experts regularly visit suppliers of materials and components to check on their quality controls.

PRODUCTION CHECKED: As well as the standard bench test, which every engine undergoes, far more extensive tests are regularly made on engines taken at random from the production lines and all ASM diesels are approved by Lloyds and the Dutch Bureau Veritas.

THERE IS NO MORE RELIABLE DIESEL ENGINE
Three models: 6-11 h.p., 14-22 h.p., 20-33 h.p. *Write now for brochures.*

ARMSTRONG SIDDELEY AIR COOLED DIESELS

ARMSTRONG SIDDELEY MOTORS Coventry and Brockworth / ENGINE BUILDERS TO THE WORLD

REGISTERED

FRONT ACCESS TYPE
for service up to 5000 amps
at 660 volts

MUDIE'S CUBICLE SWITCHGEAR

MUDIE'S ELECTRICAL CO. LTD. BIRMINGHAM 28

TRADE MARK

YARROW

shallow draft vessels, land and marine boilers

SHIPBUILDERS

ENGINEERS

BOILERMAKERS

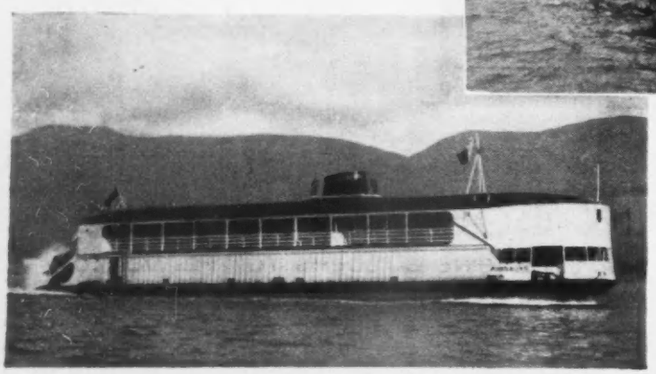
For ninety years Yarrow & Company Ltd have specialised in the design and construction of naval ships and shallow draught vessels of all types.

Yarrow Water Tube Boilers are installed in many of the world's largest and most modern Power Stations. Likewise, many of the world's most famous ships have boilers of Yarrow design.

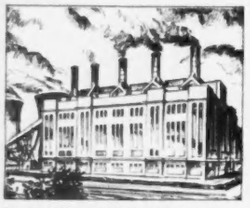
A Research Department is fully engaged in the design and development of high power propulsion machinery and nuclear activities are playing an increasing part in the work of this Department.

HMCS ST LAURENT *Anti-submarine destroyer escort vessel Machinery installation designed and supplied by Yarrow.*

PONDAUNG *One of five quarter wheel motor passenger vessels for service on the Irrawaddy.*



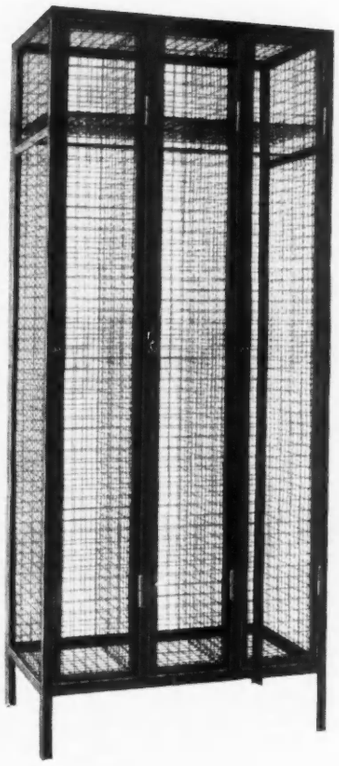
ROOSECOTE POWER STATION



BULAWAYO POWER STATION

CLYDE'S MILL POWER STATION

YARROW AND COMPANY LIMITED · SCOTSTOUN · GLASGOW W4



An Important Amenity

Friction between employees, and confusion at going-home time may be avoided by providing separate receptacles for clothes and personal belongings. Such provision is also important in the interest of hygiene. 'Harco' Clothes Lockers provide the answer. They are made in sheet metal or wirework, in nests of up to five in one unit, with short or full length compartments as required. Steel lockers are fitted with six-lever locks which can differ up to 1600; wirework lockers have rings for padlocks. Height of both types is 72 ins.

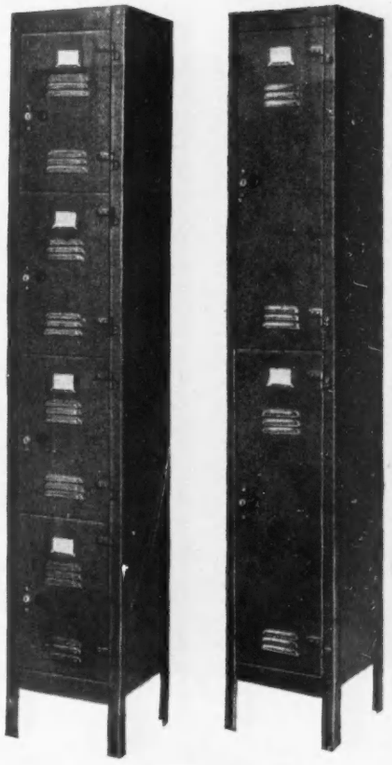
WIREWORK LOCKERS

Standard sizes:

72 in. high x 12 in. wide x 12 in. deep

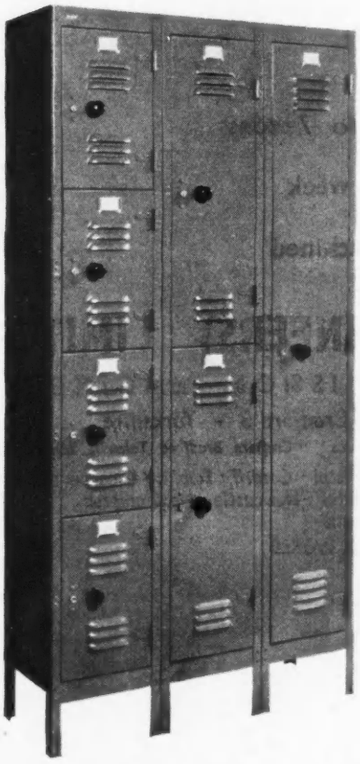
72 in. high x 10 in. wide x 18 in. deep

Please send for List No. E 1009



Wirework or Sheet Metal

in single units or nests of 2-5 as required



STEEL LOCKERS

Overall sizes:

72 in. high x 12 in. wide x 12 in. deep

72 in. high x 15 in. wide x 15 in. deep

72 in. high x 18 in. wide x 18 in. deep

1, 2 or 4 compartments per locker

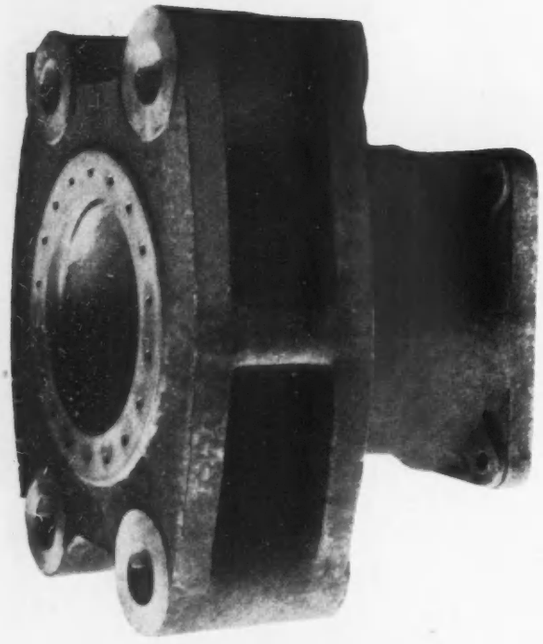
Please send for List No. E 960

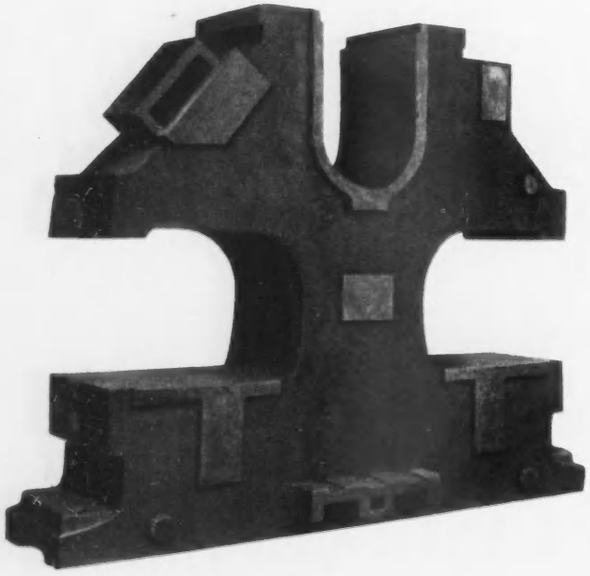
'Harco' Clothes Lockers

ARE HYGIENIC, DURABLE AND EASY TO INSTALL

Harvey

G. A. HARVEY & CO. (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7. GREenwich 3232 (22 lines)





Crofts foundries are producing some of the world's finest steel castings

gears up to 185″

individual castings up to 7 tons

capacity 100 tons per week

as cast or finished machined

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

Head Office - Thornbury - Bradford 3 - Yorkshire

Phone : 65251 (20 lines) *Grams : "Crofters Bradford Telex", Telex 51186*

Branches: Belfast · Birmingham · Bristol · Cardiff · Dublin · Glasgow · Ipswich Leeds · Liverpool · London · Manchester · Newcastle · Northampton Nottingham · Sheffield · Stoke-on-Trent

REPRESENTED THROUGHOUT THE WORLD

THE ENGINEER

No. 5363 NOVEMBER 7, 1958 VOL. 206

" OFF-PEAK " ELECTRICITY

Last week we published an article by Sir Henry Clay discussing the relationship between the tariff structure and load factor of electricity supply to industry. The underlying theme of the article is the need to find load for the efficient base load stations during the night and week-ends. Sir Henry contends that industry receives little encouragement to take off-peak supplies of electricity. For the Central Electricity Generating Board's tariff, with its fixed unit charge whatever the time of day, ignores the fact that no additional capital equipment is needed to supply loads at night when only the most efficient stations are running, with the lowest fuel cost per unit sent out. In fact, the tariff " can be said to subsidise the peak load day users as against the high load factor users." It is suggested that the C.E.G.B. should reduce the " unit charge " during the night and at week-ends and should lower the " coal increment " factor in the tariff at these off-peak times, even if it means some increase in the day-time charges. Specifically, Sir Henry asserts that the C.E.G.B. could sell power to the Area Boards at night and week-ends at a unit rate of about 0·35d., with a coal increment of 0·0005d. per 1d. change in the cost of coal per ton. He also criticises some of the Area Boards' industrial tariffs on the ground that, in effect, they penalise consumers having high load factors. To support this criticism he quotes an example of a tariff for an industrial consumer with a demand above 500kVA, using more than 4200 units per annum, and seeks to show that such a consumer, whose load factor is 48 per cent, pays the equivalent of a surcharge up to £1 18s. 9d., compared with consumers having low load factors. Sir Henry's arguments, which merit the closest study, need not be elaborated here, for they are set out in detail in his article on page 685 of last week's issue.

But it is not only the industrial consumer who is entitled to expect a tariff that more accurately represents the actual cost of giving electricity supplies. Domestic and commercial consumers, too, should be actively encouraged to use less electricity during the daytime and more at night, particularly over the week-end. What is being done about it ? The last annual report of the Central Electricity Authority claims that the importance of developing a " substantial off-peak load as a means of improving the national load factor is fully recognised, particularly for space heating by the promotional restricted hour tariff rates now offered by all Area Boards." Not all the Area Boards, however, are equally zealous in publicising the availability of favourable off-peak tariffs for space heating by floor warming cables or by thermal storage block heaters. Of all the Area Boards only about half, we are told, publish details of their reduced rates ; in the other areas the rates available are offered under agreement. A few of the areas appear to have made some progress. The Eastern Board, for example, reports over 2MW of off-peak heating installed last year, an increase of 22 per cent compared with the previous year. In the North Western Area about 9MW of transportable thermal storage block heaters were installed last year in various premises, including offices, shops, mills, schools, warehouses, hotels and hospitals. In the London area we are told that the total load of block thermal storage heaters in offices and similar premises now exceeds 18MW and that " development of floor warming by electricity is proceeding." But, since the total number of consumers on the Board's system is nearly 1,750,000, the prospective market is virtually untouched.

We believe that many of the Area Boards are not nearly active enough in their efforts to promote these restricted-hour concessions. Most of these concessions, curiously enough, appear to be directed at commercial rather than domestic users. Yet if electricity is to be used for heating private dwellings (and that, perhaps, is a natural trend in prosperous times) it should be logical, surely, for the Area Boards to offer financial inducements to encourage off-peak rather than direct heating. Furthermore, in most of the Area Boards' efforts to develop off-peak loads all the emphasis is on space heating, with hardly a mention of water storage heating by immersion heater or other means. This rather half-hearted approach contrasts strongly with the enterprise of the Electrical Development Association, which has produced many excellent films explaining and publicising the use of electricity in the factory, the office and the home. A recent film, " The Future is Electric," shows the place of electricity against the background of the Clean Air Act. It shows that the biggest offenders against clean air are the millions of domestic chimneys. It shows that, as an alternative, electricity is clean and convenient. To the Area Boards, which are in direct contact with the consumer, falls the real task of convincing him that electricity is not only clean and convenient for heating space and water, but can also be cheap to run.

VALUE OF CONFERENCES

Since the war far more conferences, extending over one, two or more days, have been organised by engineering institutions in this country than before the war. In the last decade, for example, the Institution of Mechanical Engineers has been directly concerned with the arrangements for nine major conferences, not to mention a number of one-day affairs and symposia. In the ten years before the war only one major conference was organised and only a very few symposia. We often wonder what is the real purpose such conferences serve. Ostensibly they are held to review the existing state of knowledge of some chosen subject. But except under special circumstances, such as the breaking down of long-maintained secrecy which gave the first Geneva Conference on the Peaceful Uses of Atomic Energy such great value, the bulk of the papers presented before conferences are of no high merit. We mean no disrespect to their authors in being thus critical. For we do not see how more than a very small proportion of the papers presented can possibly be of very much account. It is, for example, too much to expect that any given research will have reached a point at which

useful results can be published just in time for the holding of the conference ; and even practical experience with new devices is worth reporting only after a suitably lengthy period of trial. Thus the majority of papers presented at any conference must necessarily cover in the main ground already covered in papers presented elsewhere ; and only a small fraction of the papers presented (the time being propitious) will be really valuable in making public new knowledge. As much could be attained, one would think, by the presentation of these few really valuable papers at an ordinary meeting followed by a discussion at which minor findings can be brought out. Yet, in fact, it is probably easier to persuade a worker in any field to present a paper to a conference than to an ordinary meeting and almost invariably those who attend a conference leave it with the conviction that it has served a really valuable purpose. Moreover, a conference attracts, ordinarily, an attendance far larger than the presentation of a paper. There, we suspect—in the weight of the attendance—lies the real value of conferences. For it is far less the information publicly presented and discussed which is important than the private clashing of minds, stimulated by formal discussion within the hall, which takes place outside it. Indeed, how little of a man's real worth as an engineer or as a man is conveyed through the medium of a printed paper or even through his presentation of a paper at a formal meeting ! To meet, to converse with, particularly to laugh with, a man hitherto known only through the written word is to find a new route to the assessment of his worth and, hence, the worth of his work. Moreover, in what curious ways cross-fertilisation works ! A man may allow his private hopes and beliefs about a research or a practical application to peep out in jests and witticism when he would never dare to suggest such ideas in a paper or mention them in a formal discussion ; and the jesting may open the door for someone else to a wider horizon thereby suggesting to him some new approach to an old problem. Conferences then are seldom very valuable for what appears in print about them afterwards. They are meeting places for a clash of minds, rather than for an exchange of formal words. That, of course, is why the technical press finds it so difficult to provide any very adequate report of them. For Heaven forbid that in talking to an editor at such a conference any participant should fear his lightest word will be reported ! Yet, paradoxically, it is those lighter words rather than the formal words which can be reported that make the conference a success. Mind makes contact directly with mind. Ideas can be informally discussed. New acquaintances can be made. It all adds up to a stimulation of cross-fertilisation. Even though we may find in any given conference little that seems worth reporting it may well be that the holding of the conference has accelerated the acquisition of engineering knowledge.

THE U.S. NAVAL BUILDING PROGRAMME

Among the 78 new United States warships provided for in the 1958–59 fiscal year are four nuclear-powered rocket launching submarines authorised by Congress against the advice of the Secretary for Defence. It is, indeed, a curious situation—inconceivable to us in this country—that a Parliament should provide funds for more ships of a certain type than have been asked for by the Defence Minister. But we have yet to understand the anxiety of the United States people not to be left behind in the missile race with Russia. More than 6500 million dollars is expected to be spent on missile and space flight projects in the United States during the year ending June, 1959. As Secretary for Defence, Mr. McElroy is not influenced by inter-Service rivalry which has been so noticeable in the past few years. He has taken the sensible view that the naval authorities must look before they leap and not burn their boats until the submarine for launching a " Polaris " rocket when submerged has been further developed. Indeed, recent announcements from the Defence Department suggest that the development of the rocket launching submarine has not all been plain sailing. The U.S. Navy has always fought shy of liquid propellant ballistic rockets such as the " Thor " and " Jupiter " on the ground that they are unsuitable for shipboard use. Early last year, however, the Aerojet General Corporation and the Thiokol Chemical Corporation proved that solid fuel could be used as a propellant for rockets with a range of 1500 miles, and orders were given to develop the " Polaris " with the utmost speed. Moreover, by that time the " Nautilus " had shown that nuclear-powered submarines could proceed at high speed submerged for as long as required, and the advantage of launching the " Polaris " from a submerged submarine at once captured the imagination.

Though no official announcement was made at the time, it was generally understood that the " Halibut," and her three nuclear-powered sisters, the " Permit," " Pollack " and " Plunger "—which had originally been designed for launching the " Regulus " flying bomb—would be converted while building for launching the " Polaris." But only a short while ago, after the conventional submarine " Grayback " had carried out trials with an improved " Regulus," the Defence Department confirmed that all the four " Halibut " class are to be equipped with this flying bomb. There is, of course, no need to assume that this decision will not be revised. But it seems an indication that " snags " of some kind have been met with in the development of the " Polaris " submarine. The " Regulus " is a first-rate missile and the improved version—" Regulus II," a guided missile, nearly 60ft in length, with a range of 1000 miles—has been thoroughly tested in carriers and other surface ships of the United States Navy. None the less, it is an air-breathing missile, powered by a turbo-jet engine, with a rocket booster to give it its initial thrust, and with a maximum speed of 1500 miles an hour. It is thus a relatively easy target for the modern fighter or anti-aircraft guided missile. Moreover, although these very large " Halibut " class submarines were designed to carry three or four of them, the missile kept ready for firing has to be stowed in a hangar and launched from a swivelling launcher on deck after the submarine has surfaced.

In spite of unofficial reports that errors in navigation have been reduced to about an eighth of a mile by the new Ship's Inertial Navigational System (S.I.N.S.)—which was used by the " Nautilus " during her remarkable voyage in Arctic waters—it may well be that the navigational problem is proving the trouble. To aim a ballistic rocket with any likelihood of getting near the target, the launching vessel must know her launching position within very narrow limits. An error of a few hundred yards at the launching point may result in a wide miss of the target 1500 miles distant. And without a marked advance in the known systems of navigation to date, it would seem impossible for a submerged submarine, which may have been under water for several hours or even days, to fix her position with the required degree of accuracy. Little authentic information is available regarding S.I.N.S., but it is believed to be based on the system tried out in long-range guided missiles, with a stable gyro platform kept in alignment with some heavenly body and with the ship's courses and speeds fed into a computer.

INDUSTRIAL HEALTH

During a recent visit to an engineering factory in Scotland, we were invited to inspect the health centre. Its equipment and organisation were explained, with a justifiable degree of pride, by the management and by the sister in charge. There, first-aid treatment is readily available to all the employees for minor accidents and ailments which, if neglected, might easily become more serious. A doctor regularly attends the centre for consultation. The factory employs about 2000 people and the value of the work of its health centre is quickly evident. Expert first-aid treatment and advice keep absenteeism to a minimum. This example is, of course, by no means an isolated one. In many large and medium-sized factories throughout this land, arrangements exist for maintaining a good standard of industrial health. There are also examples of health services in which smaller firms participate on a co-operative basis, such as the industrial health centres at Harlow and Slough.

But, as in most things, there is still room for improvement. Within the last few days, there has been published the annual report, by the Chief Inspector of Factories, on industrial health. This report says there has been evidence during the past year that " not enough attention is paid by factory occupiers to making adequate provision for first-aid treatment, as required under the Factories Act." Attention is drawn to the statutory requirement that factories employing more than fifty people are required to have a trained first-aider in charge of the first-aid box. Mention is also made of the " inadequate stocks of first-aid requisites " in many factories visited by the inspectorate. Measures designed to stimulate the recruitment and training of first-aiders have been discussed and in the report the hope is expressed that " first-aid personnel in industry with the necessary qualifications will extend their knowledge by taking the more specialised first-aid training which is directly related to particular health hazards." The factory inspectorate's task in so far as industrial health is concerned is not an easy one ; it is a task which has to be approached with understanding. But neither is it always easy for managements, particularly the managements of small factories, to find people who are willing and able to acquire the training which will measure up to the standard advocated in the inspector's report. An extension of the area industrial health service schemes, such as those we have mentioned, would undoubtedly go a long way towards effecting the improvements which the factory inspectorate properly considers to be essential. An industrial health centre, set up to serve a particular area, can do more than deal with minor injuries and simple treatments. If organised aright, it can establish facilities for research directly related to industrial health hazards.

VACATIONS ABROAD FOR STUDENTS

It is with sorrow, though not with surprise, that we note from the eleventh annual report of the International Association for the Exchange of Students for Technical Experience that for the first time since the Association came into being there was a fall in the number of students exchanged. As compared with 5934 students exchanged in 1957 only 5394 were exchanged in 1958. No doubt the world-wide falling off in productive output was the cause. However, the number of member countries rose from twenty-three to twenty-four and industrial firms and universities and colleges participating all increased, and for a reason not easily derived from the report the number of university faculties covered rose from thirty-two to forty. The faculties covered include a variety of subjects which have little or no relationship to engineering ; but it is for the study of engineering or related subjects that the great bulk of students go abroad during their summer vacations, receiving from the firms participating (or from the industrial organisation involved) practical training and a sufficient amount of money to meet their cost-of-living expenses. As might be expected of an Association whose object it is to aid students to go abroad merely for a few weeks rather than for periods reckoned in months or years, the countries which are members are predominantly European ; indeed, more than half the students exchanged moved between only half a dozen countries, headed by Germany and Great Britain. But the U.S.A. and Canada are members and so are South Africa and Ceylon ; and U.N.E.S.C.O. is helping I.A.E.S.T.E. financially to investigate the possibilities for an increased exchange of students in South Africa and North Africa. We hope it can be confidently predicted that, provided the economic situation improves, more and more students will take advantage of I.A.E.S.T.E. to get abroad. For nowadays no country has a monopoly in making advances in any technology and, consequently, it is especially valuable for students to make contacts, happy and friendly contacts, with firms in other nations. Thereby the rapidity with which technological advances can be made will be facilitated in the future by a greater ease in international collaboration.

The Engineer—100 Years Ago (NOVEMBER 5, 1858)

" THE BESSEMER PROCESS IN SWEDEN "

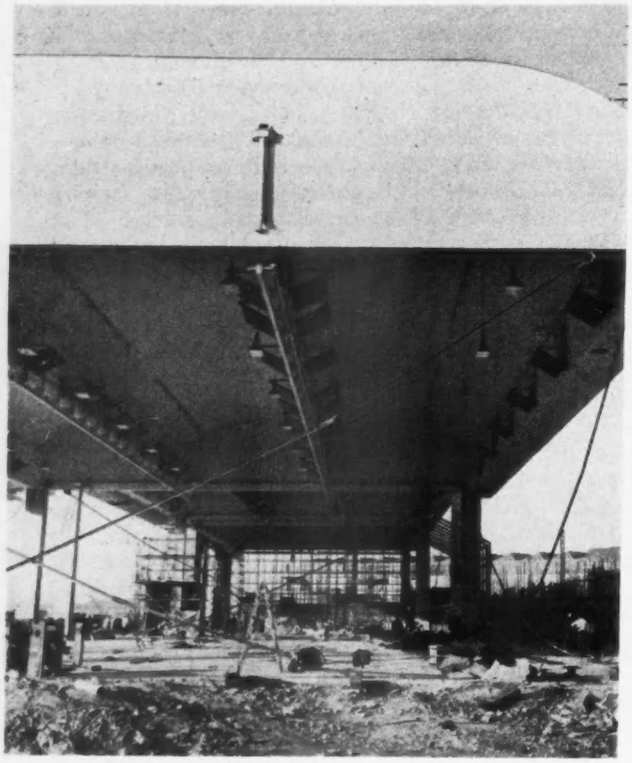
" For a considerable time after the announcement of Mr. Bessemer's discovery, our most experienced iron and steel manufacturers believed that nothing of any value could come of it. A great Sheffield authority denied that Bessemer's product could ever admit of being made into a boring tool, a cutter, a tap, or a die ; denying, in fact, that it was steel. And nearly all agreed that it was not malleable iron—that it was red-short, and had no weld. The discovery at length took the character of an interesting phenomenon having little or no commercial value. It might have been regarded, perhaps, as the germ from which some really successful process was yet to spring, to revolutionise at once the iron manufacture of the world.

" While public attention was subsiding, and Mr. Bessemer was being left to his disappointment, a Swedish iron-master, who had examined the process at Baxter House, ordered the requisite blast apparatus to be sent to his works at Edsken, and after a considerable delay in experimenting, succeeded in establishing the manufacture of good steel, on a practical scale, by the Bessemer process. The Swedish magnetic ores reduced with charcoal yield an iron free from phosphorus and sulphur. With this iron, Mr. Göransson has been enabled to devote his entire establishment to the manufacture of steel by the Bessemer process. . . . This steel has been made into engineers' tools, boiler plates, and cutlery. . . . It may prove that with simple treatment English iron may be also made by the same process into good steel. . . . It would appear, from all that we now know of the chemical constitution of iron, that the link wanting to complete the Bessemer process, so as to make good malleable iron, is very slight, and certain of early discovery. The subject is in proper hands, and the results must be patiently awaited."

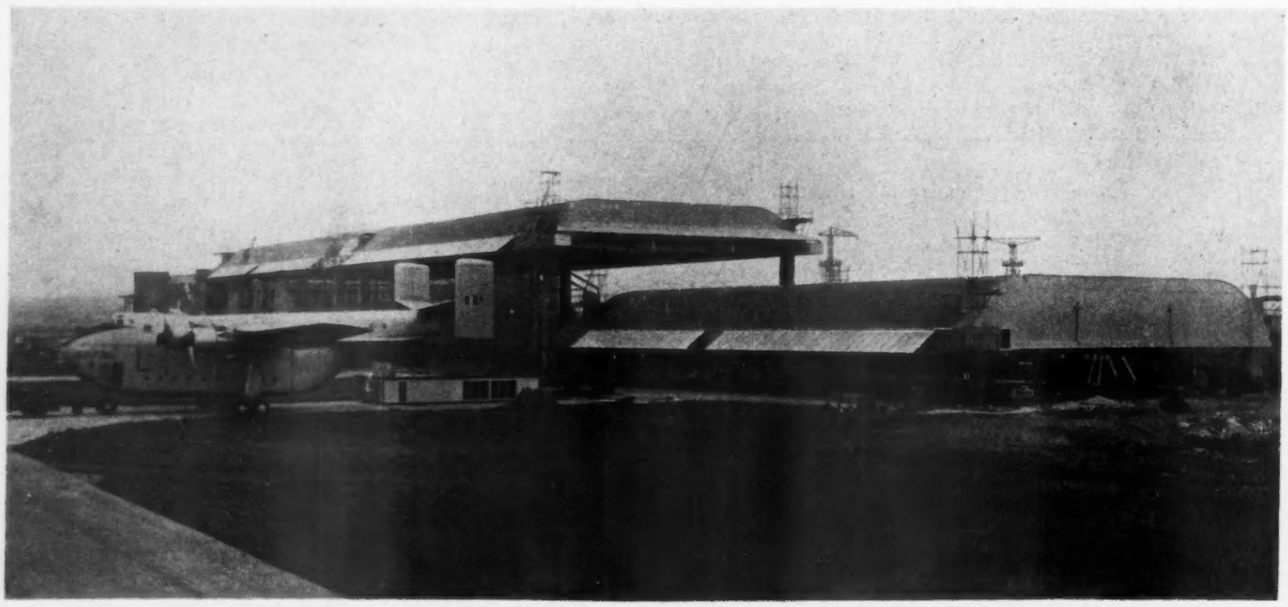
Shell-Roofed Hangars at Abingdon

Royal Air Force Transport Command's three new hangars at Abingdon each cover 186ft by 110ft. Three reinforced-concrete barrel-vault shells (3¼ in thick at the crown) span the longitudinal direction of each hangar, with box beams at each edge, a deep stiffening beam along each of the two valleys between the shells, and a gable beam enclosing each end ; all of these beams were prestressed on the Freyssinet system. The complete roof structure, as just described, was constructed on the ground and raised into position by jacking the four columns at the corners. The weight of each roof was about 1400 tons and the height of the lift 46ft. Construction of the primary structure was then completed by prestressing the four columns, on the Lee-McCall system.

Construction in prestressed concrete has led to a wider and more adventurous use of hydraulic jacking to lift, to move, or to re-distribute the loads in structures. However the present example is unprecedented in this country, and as far as we know, there has been only one other comparable example, namely, the shell-roofed hangars at Marignane in the South of France which are even larger and more complex (see "The Engineer," page 197, February 6, 1953). At Abingdon, competitive designs were called for. Repetition, few points of support, and the rails for an overhead crane, were features of the specification which lent economy to the method now described.



The UPPER RIGHT illustration shows lifting in progress at one column. There are four 200-ton jacks at ground level, each with a locking nut which is continuously turned so that a hydraulic failure would not result in settlement. A tolerance of 1in is permitted between levels at the four corners. Note the T-shaped precast blocks which are successively inserted in pairs above corresponding jacks, with the two other jacks locked. On the right is a template for adjusting the thickness of the mortar on top of the block from measurements taken with a spirit level on the base of the last block in place. Load is transferred to the mortared joint immediately ; tests showed that with stiff mortar "squeezing out" was limited, and an interval for setting was unnecessary. The illustration on the LEFT shows the structural system of one hangar roof, with crane rails fastened to the intermediate edge beams, and roof lights and other fixtures in position. Note the guys (one is in the foreground) which are the sole wind-bracing (they are tightened every night) until the columns are post-tensioned. The LOWER VIEW shows the last roof being lifted, and one of the "Beverley" aircraft which are to be maintained in the hangars. Lifting is carried out in about a week for each hangar. In the last stage, the roof is lifted 1in above its final position, two jacks are removed, and two large precast blocks inserted. The two remaining jacks are then lowered and the weight taken on the blocks. With care, the lifting has not proved unduly hazardous or complicated ; the design included an allowance for unequal reactions, but was otherwise not greatly affected. It is stated to be 10 per cent cheaper than the next design in the competition (other designs were in steel, light alloy and concrete) and 28 per cent below the highest. Consultant : Messrs. Ove Arup and Partners. Contractor : John Laing and Son, Ltd.



Institution of Civil Engineers

PRESIDENTIAL ADDRESS

The new president of the Institution of Civil Engineers, Professor A. J. S. Pippard, delivered his presidential address to the Institution on Tuesday. The professor directed his remarks in particular to younger civil engineers; he broke with tradition in that his own special field—the development of engineering education—was referred to only in certain aspects, the address being entitled "The Individual, the Profession, and the Institution." Some of Professor Pippard's more challenging opinions on this subject of the relationship of the individual to his profession are given in the following abstracts from his address.

THE civil engineer in England to-day does not legally require a diploma to practise his profession. This curious state of affairs periodically leads to questions as to why the Institution does not take steps to make the profession a closed one and so prevent any but qualified persons from practising. The reasons which have caused successive councils to refrain from such action are, in my view, cogent; one important consideration is that registration would have to be extended to all those who were practising when the register came into operation whatever might be their lack of qualification. This could well result in a serious depreciation of standards, the effects of which might remain with us for a long time.

It is interesting that the same argument can be used in a somewhat contrary sense. About two years ago I addressed a luncheon meeting of the Illinois branch of the American Society of Civil Engineers in Chicago on professional education and training in the United Kingdom. It is usual at these meetings to propound a question—sometimes serious, sometimes, I believe, not so serious—to which each member in turn gives an answer. Being invited by the chairman to set the question for the day, I, on the spur of the moment, suggested that he should ask whether it was thought preferable that the profession in America should be controlled by its own Society as in the United Kingdom, or by means of State licence to practise, as at present. There was a big majority in favour of State registration for the very reason given against its adoption here; existing requirements were well known and worked satisfactorily and any change might result in less competent people being allowed to practise on equal terms with those already licensed. It is quite clear that engineers on both sides of the Atlantic, like most other people, prefer the devil they know to one they do not.

The apparently casual attitude towards the competence or otherwise of those entrusted with engineering work of major importance which persisted for so long appears to have been in line with the characteristically early Victorian outlook on education generally, if we may judge from the views attributed to Lord Melbourne by Lord David Cecil. He says: "Only the intelligent in Melbourne's view, were susceptible to real education, and surely the intelligent always educated themselves. Anyway, he sometimes wondered if education was really of any use, so far as success in life was concerned. The careers of his acquaintances seemed to indicate the reverse. 'I do not know why there is all this fuss about education,' he once remarked to Queen Victoria, 'none of the Paget family can read or write and they do very well.'"

From the same source we learn that Melbourne was against schemes for popular education on the grounds that: "You may fill a person's head with nonsense which may be impossible ever to get out again."

From the earliest days of professional civil engineering there were divergent views, as I have already indicated, and the opposing schools of thought were well exemplified by Smeaton and Rennie respectively. Accordording to Smiles one of Smeaton's rules was never to trust to deductions drawn from theory in any case where there was an opportunity for actual experiment: "In my own practice," he said, "almost every successive case would have required an independent theory of its own. In my intercourse with mankind I have always found those who would thrust theory into practical matters to be, at bottom, men of no judgment, and pure quacks."

Rennie, on the other hand, was mathematically minded: "Unlike some of his contemporaries, Mr. Rennie did not profess a disregard for theory; for he held that true practice could only be based on true theory. Taken in the sense of mere speculative guessing, however ingenious, he would have nothing to do with it; but as a matter of inference and demonstration from fixed principles, he held by theory as his sheet anchor. His teacher [at Edinburgh University], Professor Robison, had not failed to impress on him its true uses in pursuit of science and art; and he never found reason to regret the fidelity with which he carried out his instructions in practice." I suspect sometimes that even to-day if a secret ballot of all our members could be taken we should find some, perhaps a considerable number, who would agree with Smeaton that theory applied to practice is the distinguishing mark of the quack, but I, naturally, like to believe that Rennie's views would receive, if not a sweeping majority, at least a very substantial one.

THE "ACADEMIC" GRADUATE

With the development of technological education and the increasing opportunities afforded for systematic study, the standard of attainment demanded from the aspirant to corporate membership has steadily grown, and whereas before the 1939–45 war only about one-half of our entrants possessed university degrees or the equivalent, that ratio has now grown to something over three-quarters; a very high proportion in any profession. We may, therefore, with considerable confidence, look forward to the near future when qualification by degrees or diplomas will be the rule for all except a very small minority, and to a somewhat more distant future when such education will be obligatory.

As one who has devoted most of his life to the education of young engineers I experience no sense of shame when I hear adverse comments upon the "academic" outlook of these young men; the criticism, I suspect, sometimes springs from the knowledge that those criticised are better equipped than their critics. The young engineer fresh from his university studies ought to be academic, i.e. he should possess as complete a background of theory as it may be possible to give him, and it is as sensible to complain of the result of this as it would be to criticise the provision of swimming baths because those who use them will be wet when they emerge. At this stage of his career the young engineer will have had little or no opportunity to temper his science with practical experience, but to suggest on that account that he must not be too well educated is to render the worst possible disservice to the profession.

The most important function of practical training is the amplification of theory by experience and it is one of the most urgent and responsible professional duties of the established engineer to deal faithfully with the young men who will ultimately succeed him and who must rely on him for the widening of outlook which will make possible the full use of the scientific education they have received.

RESEARCH

My views on research being what they are, I make no apology for emphasising this topic to-night and for reiterating what I have so often said in the past, namely, that as an Institution we ought to pay a great deal more attention to the development of this side of our activities. A research committee charged with the duty of encouraging such work in the universities and elsewhere, and acting as a co-ordinating body and clearing-house is a vital necessity. During the last few years our attitude to this responsibility has become healthier but I look forward to the time when we shall have established such an organisation and acquired such a reputation that adequate funds will be placed at our disposal for the encouragement of investigations which we know to be important for the proper advancement of our scientific knowledge. Perhaps I am unduly hopeful—but it is, I think, an objective worthy of effort.

An allied problem is that of the position of the research worker, and I hope that the time will soon come when we shall recognise more generously than in the past that engineering scientists constitute a definite and essential branch of our profession. In this respect also the climate has distinctly changed for the better during the last decade but there is still some way to go before the position is entirely satisfactory. You will remember that I am with Rennie rather than Smeaton on this question, and I believe that men or women who are seriously engaged in research in fields of importance to the civil engineer should not only be permitted to join us on equal terms with practitioners if they so wish, but should be actively encouraged to do so. They will prove to be a source of strength to the Institution.

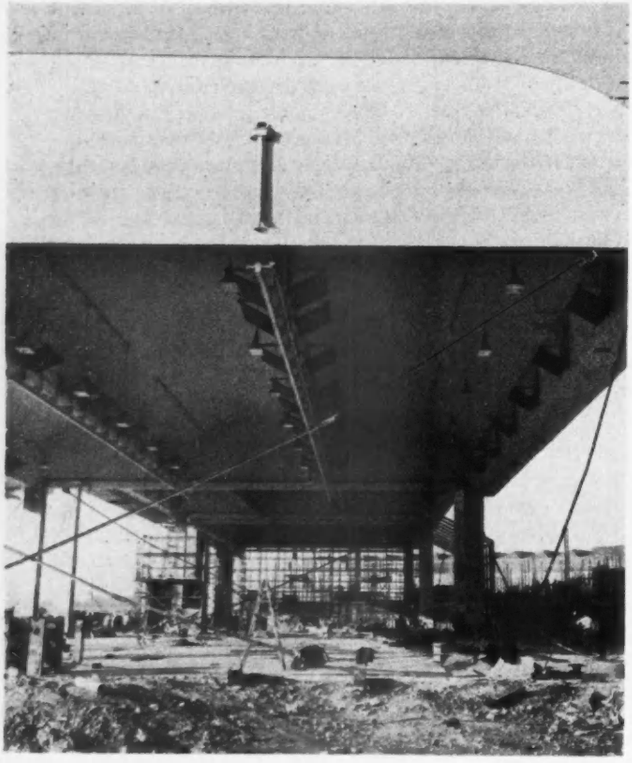
POST-GRADUATE STUDIES

During the present century the presidential chair has twice before been occupied by university professors; in 1911 by Dr. William Cawthorne Unwin, F.R.S., my distinguished predecessor at the City and Guilds College, and in 1941 by Sir Charles Inglis, F.R.S., of Cambridge. Both of them reviewed the state of education in civil engineering and it is of interest to note that their attention was directed almost entirely to undergraduate

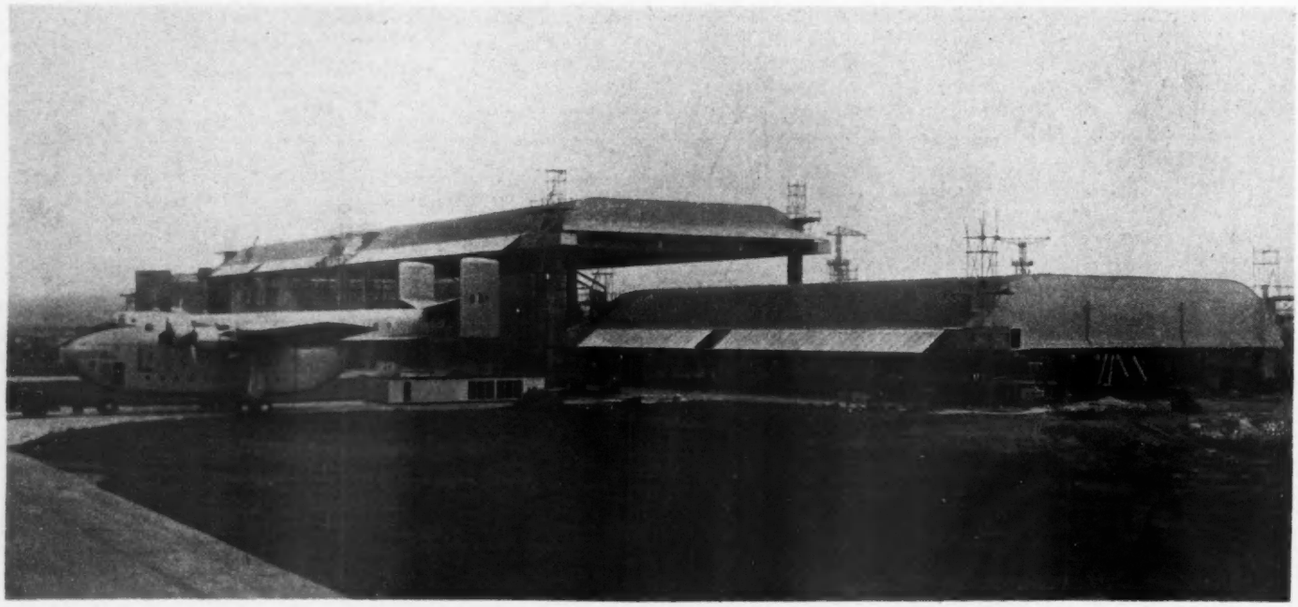
Shell-Roofed Hangars at Abingdon

Royal Air Force Transport Command's three new hangars at Abingdon each cover 186ft by 110ft. Three reinforced-concrete barrel-vault shells (3¼ in thick at the crown) span the longitudinal direction of each hangar, with box beams at each edge, a deep stiffening beam along each of the two valleys between the shells, and a gable beam enclosing each end ; all of these beams were prestressed on the Freyssinet system. The complete roof structure, as just described, was constructed on the ground and raised into position by jacking the four columns at the corners. The weight of each roof was about 1400 tons and the height of the lift 46ft. Construction of the primary structure was then completed by prestressing the four columns, on the Lee-McCall system.

Construction in prestressed concrete has led to a wider and more adventurous use of hydraulic jacking to lift, to move, or to re-distribute the loads in structures. However the present example is unprecedented in this country, and as far as we know, there has been only one other comparable example, namely, the shell-roofed hangars at Marignane in the South of France which are even larger and more complex (see "The Engineer," page 197, February 6, 1953). At Abingdon, competitive designs were called for. Repetition, few points of support, and the rails for an overhead crane, were features of the specification which lent economy to the method now described.



The UPPER RIGHT illustration shows lifting in progress at one column. There are four 200-ton jacks at ground level, each with a locking nut which is continuously turned so that a hydraulic failure would not result in settlement. A tolerance of 1in is permitted between levels at the four corners. Note the T-shaped precast blocks which are successively inserted in pairs above corresponding jacks, with the two other jacks locked. On the right is a template for adjusting the thickness of the mortar on top of the block from measurements taken with a spirit level on the base of the last block in place. Load is transferred to the mortared joint immediately ; tests showed that with stiff mortar "squeezing out" was limited, and an interval for setting was unnecessary. The illustration on the LEFT shows the structural system of one hangar roof, with crane rails fastened to the intermediate edge beams, and roof lights and other fixtures in position. Note the guys (one is in the foreground) which are the sole windbracing (they are tightened every night) until the columns are post-tensioned. The LOWER VIEW shows the last roof being lifted, and one of the "Beverley" aircraft which are to be maintained in the hangars. Lifting is carried out in about a week for each hangar. In the last stage, the roof is lifted 1in above its final position, two jacks are removed, and two large precast blocks inserted. The two remaining jacks are then lowered and the weight taken on the blocks. With care, the lifting has not proved unduly hazardous or complicated ; the design included an allowance for unequal reactions, but was otherwise not greatly affected. It is stated to be 10 per cent cheaper than the next design in the competition (other designs were in steel, light alloy and concrete) and 28 per cent below the highest. Consultant : Messrs. Ove Arup and Partners. Contractor : John Laing and Son, Ltd.



Institution of Civil Engineers

PRESIDENTIAL ADDRESS

The new president of the Institution of Civil Engineers, Professor A. J. S. Pippard, delivered his presidential address to the Institution on Tuesday. The professor directed his remarks in particular to younger civil engineers; he broke with tradition in that his own special field—the development of engineering education—was referred to only in certain aspects, the address being entitled "The Individual, the Profession, and the Institution." Some of Professor Pippard's more challenging opinions on this subject of the relationship of the individual to his profession are given in the following abstracts from his address.

THE civil engineer in England to-day does not legally require a diploma to practise his profession. This curious state of affairs periodically leads to questions as to why the Institution does not take steps to make the profession a closed one and so prevent any but qualified persons from practising. The reasons which have caused successive councils to refrain from such action are, in my view, cogent; one important consideration is that registration would have to be extended to all those who were practising when the register came into operation whatever might be their lack of qualification. This could well result in a serious depreciation of standards, the effects of which might remain with us for a long time.

It is interesting that the same argument can be used in a somewhat contrary sense. About two years ago I addressed a luncheon meeting of the Illinois branch of the American Society of Civil Engineers in Chicago on professional education and training in the United Kingdom. It is usual at these meetings to propound a question—sometimes serious, sometimes, I believe, not so serious—to which each member in turn gives an answer. Being invited by the chairman to set the question for the day, I, on the spur of the moment, suggested that he should ask whether it was thought preferable that the profession in America should be controlled by its own Society as in the United Kingdom, or by means of State licence to practise, as at present. There was a big majority in favour of State registration for the very reason given against its adoption here; existing requirements were well known and worked satisfactorily and any change might result in less competent people being allowed to practise on equal terms with those already licensed. It is quite clear that engineers on both sides of the Atlantic, like most other people, prefer the devil they know to one they do not.

The apparently casual attitude towards the competence or otherwise of those entrusted with engineering work of major importance which persisted for so long appears to have been in line with the characteristically early Victorian outlook on education generally, if we may judge from the views attributed to Lord Melbourne by Lord David Cecil. He says: "Only the intelligent in Melbourne's view, were susceptible to real education, and surely the intelligent always educated themselves. Anyway, he sometimes wondered if education was really of any use, so far as success in life was concerned. The careers of his acquaintances seemed to indicate the reverse. 'I do not know why there is all this fuss about education,' he once remarked to Queen Victoria, 'none of the Paget family can read or write and they do very well.'"

From the same source we learn that Melbourne was against schemes for popular education on the grounds that: "You may fill a person's head with nonsense which may be impossible ever to get out again."

From the earliest days of professional civil engineering there were divergent views, as I have already indicated, and the opposing schools of thought were well exemplified by Smeaton and Rennie respectively. Accordording to Smiles one of Smeaton's rules was never to trust to deductions drawn from theory in any case where there was an opportunity for actual experiment: "In my own practice," he said, "almost every successive case would have required an independent theory of its own. In my intercourse with mankind I have always found those who would thrust theory into practical matters to be, at bottom, men of no judgment, and pure quacks."

Rennie, on the other hand, was mathematically minded: "Unlike some of his contemporaries, Mr. Rennie did not profess a disregard for theory; for he held that true practice could only be based on true theory. Taken in the sense of mere speculative guessing, however ingenious, he would have nothing to do with it; but as a matter of inference and demonstration from fixed principles, he held by theory as his sheet anchor. His teacher [at Edinburgh University], Professor Robison, had not failed to impress on him its true uses in pursuit of science and art; and he never found reason to regret the fidelity with which he carried out his instructions in practice." I suspect sometimes that even to-day if a secret ballot of all our members could be taken we should find some, perhaps a considerable number, who would agree with Smeaton that theory applied to practice is the distinguishing mark of the quack, but I, naturally, like to believe that Rennie's views would receive, if not a sweeping majority, at least a very substantial one.

THE "ACADEMIC" GRADUATE

With the development of technological education and the increasing opportunities afforded for systematic study, the standard of attainment demanded from the aspirant to corporate membership has steadily grown, and whereas before the 1939–45 war only about one-half of our entrants possessed university degrees or the equivalent, that ratio has now grown to something over three-quarters; a very high proportion in any profession. We may, therefore, with considerable confidence, look forward to the near future when qualification by degrees or diplomas will be the rule for all except a very small minority, and to a somewhat more distant future when such education will be obligatory.

As one who has devoted most of his life to the education of young engineers I experience no sense of shame when I hear adverse comments upon the "academic" outlook of these young men; the criticism, I suspect, sometimes springs from the knowledge that those criticised are better equipped than their critics. The young engineer fresh from his university studies ought to be academic, i.e. he should possess as complete a background of theory as it may be possible to give him, and it is as sensible to complain of the result of this as it would be to criticise the provision of swimming baths because those who use them will be wet when they emerge. At this stage of his career the young engineer will have had little or no opportunity to temper his science with practical experience, but to suggest on that account that he must not be too well educated is to render the worst possible disservice to the profession.

The most important function of practical training is the amplification of theory by experience and it is one of the most urgent and responsible professional duties of the established engineer to deal faithfully with the young men who will ultimately succeed him and who must rely on him for the widening of outlook which will make possible the full use of the scientific education they have received.

RESEARCH

My views on research being what they are, I make no apology for emphasising this topic to-night and for reiterating what I have so often said in the past, namely, that as an Institution we ought to pay a great deal more attention to the development of this side of our activities. A research committee charged with the duty of encouraging such work in the universities and elsewhere, and acting as a co-ordinating body and clearing-house is a vital necessity. During the last few years our attitude to this responsibility has become healthier but I look forward to the time when we shall have established such an organisation and acquired such a reputation that adequate funds will be placed at our disposal for the encouragement of investigations which we know to be important for the proper advancement of our scientific knowledge. Perhaps I am unduly hopeful—but it is, I think, an objective worthy of effort.

An allied problem is that of the position of the research worker, and I hope that the time will soon come when we shall recognise more generously than in the past that engineering scientists constitute a definite and essential branch of our profession. In this respect also the climate has distinctly changed for the better during the last decade but there is still some way to go before the position is entirely satisfactory. You will remember that I am with Rennie rather than Smeaton on this question, and I believe that men or women who are seriously engaged in research in fields of importance to the civil engineer should not only be permitted to join us on equal terms with practitioners if they so wish, but should be actively encouraged to do so. They will prove to be a source of strength to the Institution.

POST-GRADUATE STUDIES

During the present century the presidential chair has twice before been occupied by university professors; in 1911 by Dr. William Cawthorne Unwin, F.R.S., my distinguished predecessor at the City and Guilds College, and in 1941 by Sir Charles Inglis, F.R.S., of Cambridge. Both of them reviewed the state of education in civil engineering and it is of interest to note that their attention was directed almost entirely to undergraduate

studies. It is true that certain aspects of more advanced work were briefly mentioned, but broadly speaking it was evident that they both deemed formal education to be completed with the attainment of a first degree. Perhaps the most significant development in the post-war era has been the extension of technological education to the post-graduate stage.

The Imperial College of Science and Technology was founded in 1907 with the grant of a charter which placed upon the college the obligation to provide the highest technical education. This duty was fulfilled by the provision of courses of post-graduate standard in a wide variety of sciences and technologies in addition to those required for normal degree work. Apart from negligibly small facilities for research in a few of the other universities in Britain, advanced studies in engineering at that date, and for some time later, were almost entirely confined to South Kensington.

In 1933 the number of post-graduate students in the civil engineering department of that college varied from fifteen to twenty-five annually and a large number of these had entered the college as undergraduates with exemption from the first year's work and from the intermediate examination by virtue of the possession of higher school certificates. Since, under university regulations, they had to complete a period of three years' residence, their last year after passing the final examination was normally in post-graduate classes. In the last years of my tenure of the chair the number of advanced students of civil engineering had risen to nearly 150 annually and none of them belonged to the category I have just mentioned, which had disappeared under post-war regulations. These post-graduate students were drawn from some forty or fifty different universities distributed all over the world—almost literally from China to Peru. I quote these figures only to emphasise the very large increase in numbers of those demanding advanced study ; a demand, I must add, which is not confined to one branch of engineering, to one university, or to one country. Indeed, the same development is apparent to such a considerably greater extent in the U.S.A. and the U.S.S.R. as to justify serious concern about our future standing in relation to other nations in the number of our technologists.

Post-graduate work in a university may consist of advanced study or research, and represents a development which has demanded serious consideration in the assessment by the Institution of professional qualifications. To what can this rapid growth be attributed ? I think the answer is that the second world war brought home very forcibly a truth which the first had strongly indicated, but which was not fully impressed on the national conscience ; that a completely new era in science had opened and that if the United Kingdom were to maintain a leading place among the nations her engineers and technologists in the new age would have to be capable of applying the great discoveries which were emerging. It became only too obvious that unless the engineer proved willing and capable of undertaking the new and greater responsibilities which were thus presented, the initiative would pass to others and he would quickly find himself relegated to the role of technical assistant to the pure and applied scientist. That possibility still remains a real danger which must be squarely faced ; there is no room for any suspicion of complacency. We are part of a new scientific world and our survival as leaders in it will depend upon the extent to which we can adapt our outlook and methods to changing circumstances.

In speaking of new discoveries in science it is all too easy to think only of the spectacular and terrifying, such as the potentialities of nuclear energy for good or ill, but as Sir George Thomson emphasised in his address to the physics section of the British Association meeting at Sheffield in 1956, there are others of no less importance. He said : " An electronic computer cannot be dropped as a bomb, and so has not quite made the headlines in the way nuclear energy has done, but I believe it is comparable in importance." He pointed out that the ability to apply precise reasoning to large amounts of data in a reasonable time was something new and the powers that it gave were still not appreciated properly, and he continued : " The introduction of electronic computers into science may prove not much less important than the introduction of mathematics in the seventeenth century."

This authoritative opinion delivered to a representative gathering of scientists and technologists should point the moral that what was good enough in the way of education for my generation of engineers can no longer be considered adequate for those who are to follow us.

Publicity for Engineering Works

The problem of ensuring proper publicity for the work of the civil engineer, and so attracting some of the best brains into this field of applied science, is one which is never long absent from the minds of the Council but it is one to which there is no clear-cut solution. To rouse the interest of the general public in the great works of construction which are being continually carried out for their ultimate benefit ought to be easy enough but in fact it is difficult. It is sad but true that the news value, for example, of a new dam which will cost millions of pounds to build and bring new hope and prosperity to vast areas and many people is insignificant in comparison with a sensational murder or the style of dress favoured by a competitor at Wimbledon.

It is, however, of no use to complain of things as they are ; the only hope is to remedy them, and herein lies the difficulty. The failure to awaken interest is not, I think, due in most instances to the subject matter but to the manner of its presentation. Descriptions of engineering works which find their way into the non-technical press are too often written in a style which has little chance of attracting general notice and since this is the whole object of such articles considered as propaganda, they must be held to have failed in their purpose.

That public interest for or against a particular engineering job can be roused by appropriate methods was shown as long ago as 1759, when Dr. Johnson himself took sides in a controversy over the projected bridge over the Thames at Blackfriars. In his biography, Boswell says : " At this time, there being a competition among the architects of London to be employed in the building of Blackfriars Bridge a question was very warmly agitated whether semicircular or elliptical arches were preferable. In the design offered by Mr. Mylne the elliptical form was adopted, and therefore it was the great object of his rivals to attack it. Johnson's regard for his friend, Mr. Gwyn, induced him to engage in this controversy against Mr. Mylne ; and after being at considerable pains to study the subject, he wrote three several letters to the *Gazetteer*, in opposition to his plan."

The few extracts which time allows me to quote from these letters will give an idea of the way the learned doctor conducted a publicity campaign. In his first he says : " Those who are acquainted with the mathematical principles of architecture are not many ; and yet fewer are they who will, upon any single occasion endure any laborious stretch of thought or harass their minds with unaccustomed investigations. We shall therefore attempt to show the weakness of the elliptical arch by arguments which appeal simply to common reason.

" All arches have a certain degree of weakness. No hollow building can be equally strong with a solid mass, of which every upper part presses perpendicularly upon the lower. Any weight laid upon the top of an arch has a tendency to force that top into the vacuity below ; and the arch thus loaded on the top stands only because the stones that form it, being wider in the upper than in the lower parts, that part that fills a wider space cannot fall through a space less wide. In proportion as the stones are wider at the top than at the bottom, they can less easily be forced downwards. Upon this plain principle the semicircular arch may be demonstrated to excell in strength the elliptical arch which approaching nearer to a straight line must be constructed with stones whose diminution downwards is very little, and of which the pressure is almost perpendicular. If the elliptical arch be equally strong with the semicircular, that is if an arch by approaching a straight line loses none of its stability it will follow that all arcuation is useless and that the bridge may at last without any inconvenience consist of stones laid in straight lines from pillar to pillar. But if a straight line will bear no weight, which is evident at the first view, it is plain likewise that an ellipsis will bear very little, and that as the arch is more curved its strength is encreased.

" If in opposition to these arguments and in defiance at once of right reason and general authority, the elliptical arch is chosen, what will the world believe than that some motive other than reason influenced the determination ? "

In reply to this letter one of Mr. Mylne's supporters pointed out that Mr. Mylne had recently received the Prize for Architecture at Rome, to which Johnson retorted : " That Mr. M—— obtained the prize of the architecture at Rome a few months ago is willingly confessed ; nor do his opponents doubt that he obtained it by deserving it. May he continue to obtain whatever he deserves ; but let it not be presumed that a prize granted at Rome implies an irresistible degree of skill. The competition is only between boys and the prize given only to excite laudable industry, not to reward consummate excellence. Nor will the suffrage of the Romans much advance any name among those who know, what no man of science will deny, that architecture has for sometime degenerated at Rome to the lowest state and that the Pantheon is now deformed by petty decorations."

The knock-out blow, however, comes in the last paragraph of the final letter : " The friend of Mr. M——, however he may be mistaken in some of his opinions does not want the appearance of reason when he prefers facts to theories ; and that I may not dismiss the question without some appeal to facts I will borrow an example suggested by a great artist* and recommend those who may still doubt which of the two arches is the stronger to press an egg first on the ends and then upon the sides."

* Presumably Sir Joshua Reynolds

Public Works Exhibition

No. I

Next Monday, the Public Works Exhibition will open at Olympia in London. The organisers state that the exhibition will be larger than before, with nearly 400 exhibitors, and they claim that nowhere else in the world is it possible to inspect such a comprehensive display of products needed by contractors or for civil engineering or municipal works of all kinds. The following review does not claim to be comprehensive, but merely selects a few of the exhibits which appear of special interest and of which we have had advance information.

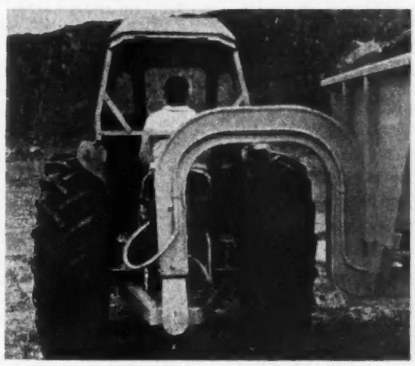
ON Monday, November 10, the Public Works and Municipal Services Congress and Exhibition, to give it its full title, will be officially opened by Mr. Henry Brooke, the Minister of Housing and Local Government. It will be the seventh such event to be held since the war, and, as customary, technical sessions will be held in the Congress Halls at Olympia throughout the week, while the exhibition also is in progress. Twenty-two papers will be presented and discussed during the municipal services congress.

The exhibition will close on the evening of Saturday, November 15. It will be larger, to the extent of 15,000 square feet, than its predecessors, and the advance information indicates that its variety and scope will ably reflect the vigour and enterprise of the many manufacturing firms which serve these particular fields. The organisers state that fewer new machines than usual will be on show ; we have, nevertheless, been given information on several new machines of special interest.

Earth Moving Plant

Our first example of the earth moving equipment which will be seen at the exhibition is not remarkable for its large size (although a complete range of equipment using the same system is planned) but rather for an attempt at economy and simplicity, which is the result of an original approach to the mechanical design of a tractor-trailer combination. The equipment we speak of is, in this case, merely a standard 50 h.p. British-made tractor of the kind used most frequently in agricultural work, to which is attached a rear-dump trailer of 7 cubic yards capacity (i.e. carrying a 10-ton pay-load), as shown in our heading illustration. The design of the trailer and its attachment illustrate what is known as the " Shawnee-Poole " system, which is being exploited jointly by the firms Steel Fabricators (Cardiff), Ltd., and H. G. Poole and Partners, Rhodesia (Pvt.), Ltd. The special claims of this system can best be explained by quoting from a recent speech made by Mr. H. G. Poole, when introducing the system to the press.

" My personal interest in the problem goes back in fact to wartime days," Mr. Poole said, " when I was increasingly impressed with the relative immobility of supposedly military vehicles which were mere adaptations of orthodox trucks and which were horribly immobile immediately they left the highway. The operator is faced with the choice between the relatively orthodox highway truck, which was never really intended for these off-the-road applications, or alternatively, the large-scale type of ' American inspired ' machine which is very costly to buy, and costly to maintain and to operate. We have therefore concentrated in evolving a method of transport which would utilise an economical and efficient prime mover based



The Shawnee-Poole coupling. Note the goose-neck, and " universal joint " between it and the forked drawbar. The drawbar forks are hinged to the tractor axle, below and in front of the axle

on the industrial version of the standard agricultural type of tractor, and linking it effectively with a simple load carrier designed specifically for the operation for which it was employed.

" The basic invention is the linkage between the prime mover, the power unit and the load-carrying element, and that linkage is mechanically simple, if somewhat involved in its geometry. The main characteristic which enables us to use a relatively light prime mover with a relatively high pay-load is that we use the pay-load to apply weight to the prime mover in such a way that the load is suspended below the tractor and is ahead of the rear axle, and in that way we actually hold the front wheels of the tractor firmly on the ground and we do this at all angles of relative movement between the tractor and the towed unit. This therefore means that the driver can negotiate any type of terrain with the throttle wide open if he feels so inclined. Other characteristics of this mechanism are that it enables the prime mover to turn through an angle not merely of 90 deg. but of 110 deg., which means that it can in fact turn back on the towed vehicle. The towed unit is fitted with compressed air brakes, and generally speaking every effort has been made to ensure that the equipment is stable with the tractor driven at normal maximum tractor speeds of 20 m.p.h. or so, and able to negotiate safely up and down any gradient which would normally be encountered on normal site conditions. The main characteristic of this unit is that it will transport a pay-load at a cost per cubic-yard-mile or per ton-mile, on whichever basis one cares to calculate it, at approximately one-half of the cost of operating any other orthodox form of equipment on the same application."

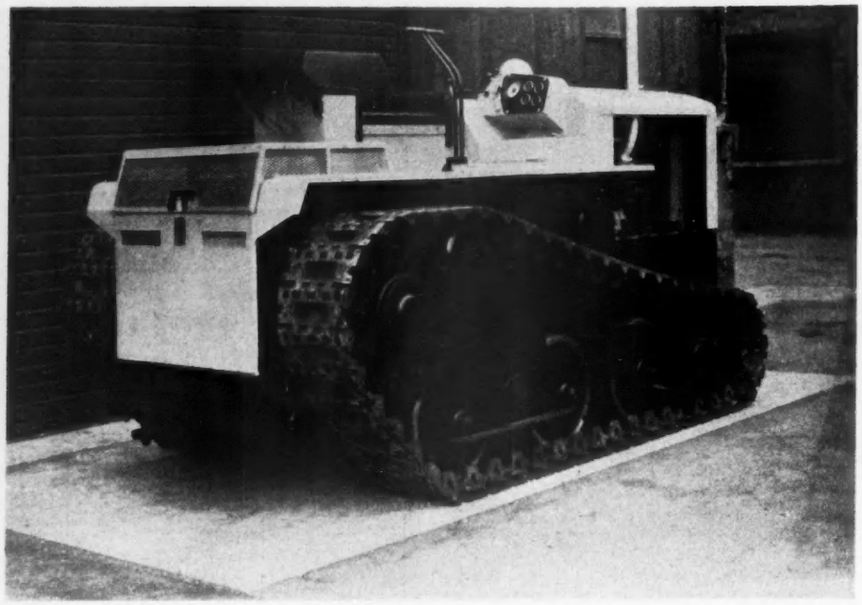
The linkage between the trailer and prime mover, to which Mr. Poole referred, consists essentially of (*a*) a hinge with a vertical axis to permit steering movements ; (*b*) a sleeve bearing along the centre line of the two vehicles, which permits the axle of the trailer to tilt independently of the tractor, and (*c*) a hinge between the front end of the assembly and the prime mover axle, which permits articulation of the kind needed to negotiate a ditch or a hump-backed bridge. The goose-neck is introduced to allow very sharp turns. Another important point is considered to be the forked drawbar, shown in the second illustration, which applies load close to the tractor wheels, thus reducing bending moment on the axle housing.

The " American-inspired " type of machine referred to by Mr. Poole will also be well in evidence at the exhibition, and will probably be at its most grandiose in the enormous Euclid twin-powered scraper of 24 cubic yards capacity to be exhibited by John Blackwood Hodge and Co., Ltd. Such machines as this are, of course, called for on only very large projects, but when seen at work their size and high speed attract immediate attention, as may perhaps be imagined from the illustration on page 719, showing the scraper at work. The 24 cubic yard measure is a struck capacity, and the machine may actually handle a heaped load of 27 or 30 cubic yards. Each of the engines are rated at 290 b.h.p. at 2100 r.p.m., so the machine has 580 h.p. available to work against its gross weight of 156,000 lb, of which the pay-load is 80,000 lb. The width of cut of the scraper is about 10ft, the wheelbase is 26ft 10in, and the overall length 45ft 7in.

Loaders and Tractor-Mounted Equipment

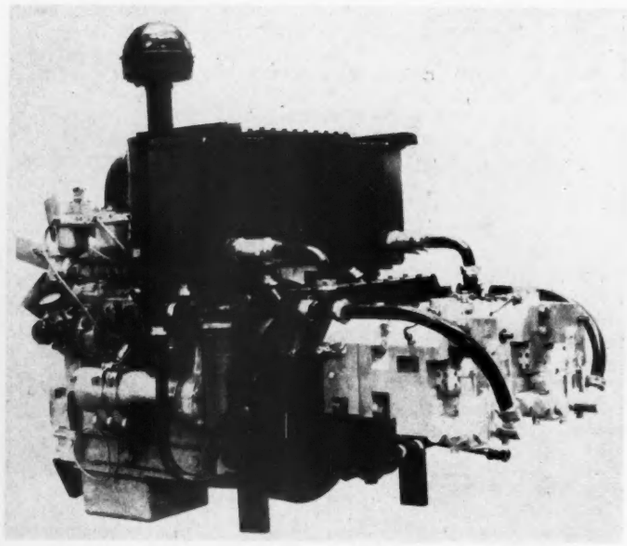
Three examples will serve to illustrate the variety of uses to which tractors of moderate size can be put, when equipped with auxiliary shovels, bulldozer blades, and similar

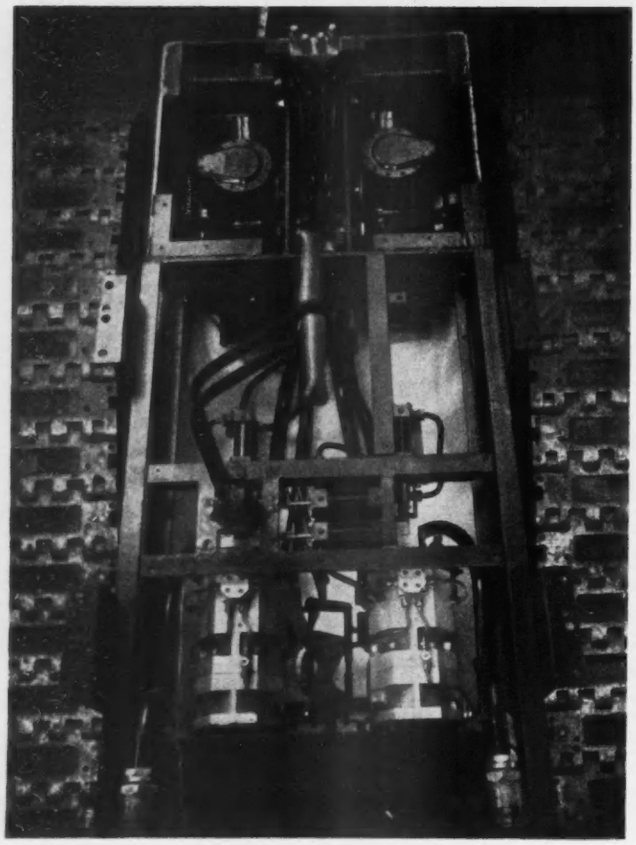
Tracklayer with Hydrostatic Transmission



There is to be displayed by W. G. Bagnall, Ltd., the prototype of a heavy crawler tractor for earth-moving and other arduous applications. This vehicle is distinguished by the use of a hydrostatic transmission, and the reversibility of such a transmission is applied to give steering control without resort to clutches or brakes : braking also is derived from the hydraulic circuit. The tractor has a single engine, a Meadows "4 DC 420," rated at 90 h.p. at 2000 r.p.m., set in the tail of the hull. The normal electric starting motor is employed. The engine is geared to two Lucas swashplate pumps which are virtually larger editions of the familiar slipper-pad seven-cylinder units for gas turbine fuel systems : the working pressure is 3000 lb per square inch.

The remainder of the transmission follows on the lines of the National Institute of Agricultural Engineering developments reported on April 27, 1956, page 406. Each pump is connected to one seven-cylinder motor and each motor to one of the sprockets : a maximum torque of 10,500 lb.-ft is developed. There are separate secondary, boost, circuits maintaining pressure in each main circuit. The tractor is controlled by varying the outputs of the pumps : it will be clear that the power fed into the inside track in a turn is made available, with a reasonable efficiency, to the outside track. The swashplates are actually set by servo motors in the pumps, and the ends of the spindle valves controlling these rams can be seen projecting from the front of the power unit on the RIGHT. These are very simple servo motors having 1 : 1 feedback, the valves being within the pistons, but in the event of failure the swashplates can be set by the driver's effort. The servos run off boost pressure when the pump is unloaded. The torque selector levers are linked to the control valves by closed hydraulic circuits, also maintained under pressure, mechanical remote controls having been deemed





too sensitive to maladjustment and to ingress of foreign matter. An additional control short-circuits the pumps and open-circuits the motors to park : the steering levers are then locked, so that the driver can pull himself out of the seat by them.

The tractor runs on two bogies each side. The front one consists of a walking beam, with a wheel at each end, extended upwards to carry a third idler supporting the top (tight when moving forward) run of the track : this geometry maintains a closely constant track tension as the suspension deflects. The rear bogey also comprises a walking beam and incorporates the track tension adjustment : the pivot of the beam can move at right angles to its length, and the beams each side of the vehicle are linked by a hydraulic suspension to give a load balance between the two. This hydraulic suspension, in common with all other moving glands, uses "Hallprene" seals of soft and hard rubber running on honed surfaces. (These seals are also used in the hydraulic suspension of Crane trailers.) It is claimed that hydraulic leakages are not a problem, and that the hydraulic system will be left sealed for, perhaps, two years at a time. The system runs on Shell "Tellus 27" : no oil cooler is necessary. If it is necessary to tow the tractor in the event of, say, an engine failure, removal of the disc seen on the driving sprocket allows it to be disconnected from the motor shaft. To absorb the irregularities of the track, the wheels are rendered resilient by incorporating rubber inserts : these are not subject to abrasion in the manner of a solid tyre.

The picture (LEFT) shows the front of the tractor with the decking removed : oil pipes run to the extreme nose to supply the attachments. The tractor weighs 8 tons and has a rated draw bar pull of 15,000 lb : its top speed is 7 m.p.h. forward or backward. It is known as the Bagnall-Burns "B.B. 90," having been designed by Mr. J. S. Burns.

equipment. An accompanying illustration shows the " Track-Marshall J.C.B." trencher, which will be exhibited by Thos. W. Ward, Ltd. This machine is essentially a combination of the " Track-Marshall " diesel crawler tractor and the " J.C.B. Hydra-Digga." The tractor is driven by a 50 b.h.p. Perkins diesel engine, giving maximum drawbar pull of 12,100 lb, and there are six forward speeds from 1·31 to 5·15 m.p.h., with two reverse speeds. The standard 14in wide track plates of the machine, with its operating weight of 11,400 lb, give a ground pressure of 5·8 lb per square inch. The machine to be shown is fitted with Marshall hydraulic angledozing equipment and other alternative equipments are available.

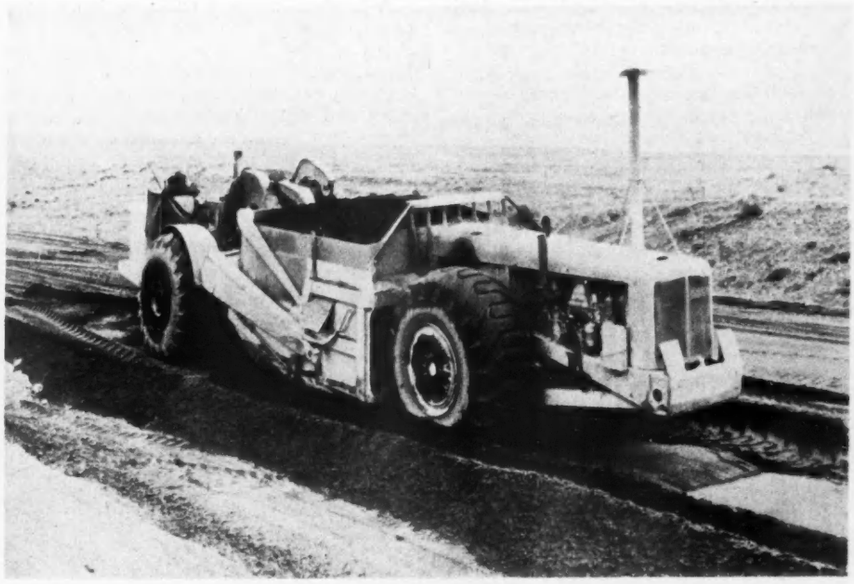
The "J.C.B. Hydra-Digga" attachment is designed for trenching, ditching, hole digging and face shovelling. Its hydraulic system provides a digging effort on the lip of the bucket of 20,000 lb minimum. The main boom rotates through 180 deg. and provides a loading height of 10ft 8in and a digging depth of 13ft. A range of trenching buckets from 6in to 52in wide is available for use on the equipment with an alternative forward-acting face shovel of 9 cubic feet. This " Hydra-Digga " can be detached.

The power shovel made by Whitlock Brothers, Ltd., Great Yeldham, Essex, is to be shown with the roll attachment, as illustrated. This roll attachment fits on to the arms of the standard shovel so that for normal transport it can be raised by the hydraulic arm equipment. Of two-cylinder construction, the rolls are 5ft wide and 3ft diameter, the weight of the attachment when water ballasted being 4500 lb. Another front end attachment introduced by this firm is a working platform equipment, which is elevated by the hydraulic rams of the shovel arms. This service platform is capable of lifting men and equipment to a maximum height of 20ft, its maximum outreach in front of the tractor is 16ft at a height of 5ft 6in and 5ft at a height of 20ft. The machine illustrated has one of the firm's $\frac{3}{8}$ cubic yard hydraulically operated grabs at its rear end.

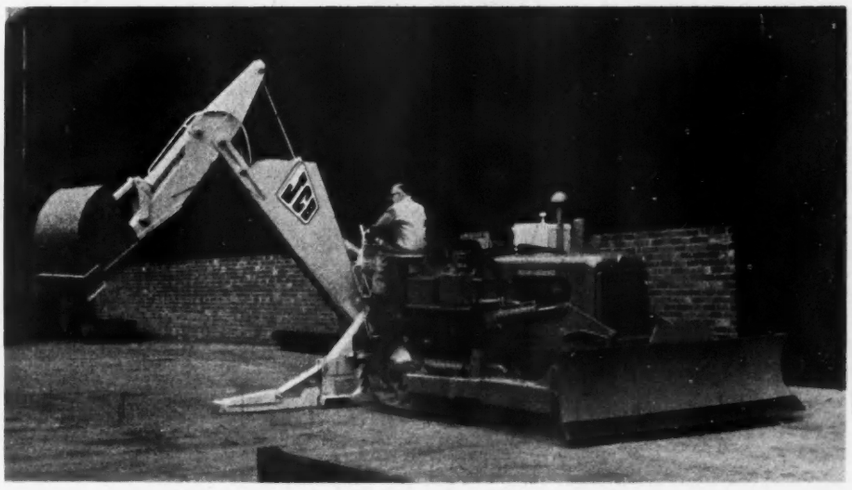
A loading shovel having a pay-load of 10,000 lb in a 3-cubic-yard nominal capacity scoop, has been developed by the Chaseside Engineering Company, Ltd., Hertford, and is known as the " Loadmaster 3000." This machine is powered by a 148 b.h.p. diesel engine and has automatic transmission and a hydraulic torque convertor which eliminates need for gear changing. Its hydraulic system is supplied by a large capacity pump driven from the engine. Four 7in diameter rams are used to operate the side arms of the scoop and impart a crowding action. This equipment provides a " pry-out " force of 22,500 lb at the toe plate of the scoop and gives a maximum lift effort of 20,000 lb. The scoop can be crowded through 90 deg. at all positions of the side arms.

The machine is mounted on four large pneumatic-tyred wheels and it has a top travelling speed of 27 m.p.h. Hydraulically operated brakes and power-assisted steering are fitted and the operator's cab provides an unobstructed view all round the machine.

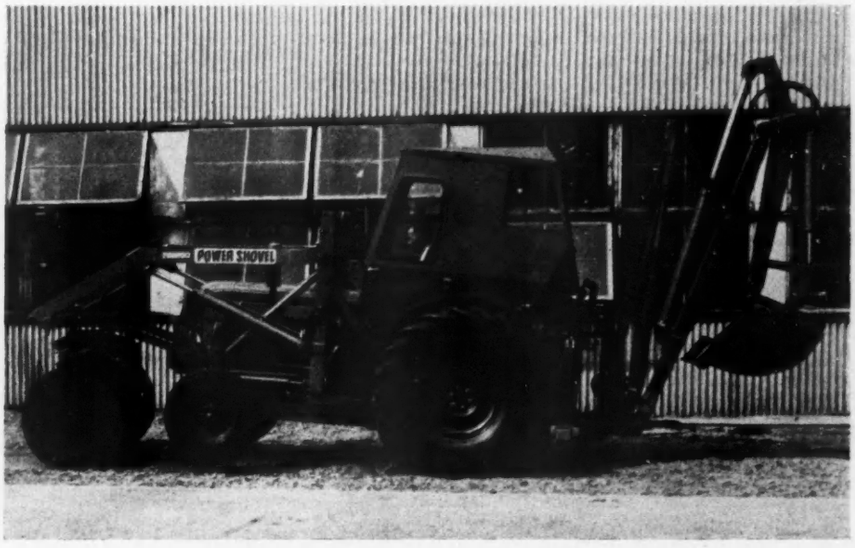
The recently introduced " Hi-Speed " dumper, which will also be seen on the Chaseside stand, has a hopper with a struck capacity of 3·4 cubic yards and a heaped capacity of 4·5 cubic yards. This machine is fitted with a Ford diesel engine, developing 61·6 b.h.p. at 2250 r.p.m., which drives through a five-speed gearbox and a transfer gearbox. The final drive, through a two-speed axle, gives ten speeds in each direction.



The Euclid TS24 twin-powered scraper is a machine of 580 h.p. The struck capacity of the scraper bowl is 24 cubic yards



" Track-Marshall " crawler tractor fitted with a " Hydra-Digger "



Whitlock roll attachment fitted to standard power shovel

Two-way steering combined with duplicated driver's controls facilitates operation of the machine in either direction of travel.

Ready-Mixed Concrete

The past few years have seen a great increase in the use of ready-mixed concrete by British contractors, and this, of course, has led to the introduction of several new truck-mounted concrete mixers and agitators intended principally for ready-mixed work. Two new designs of Ransomes and Rapier, Ltd., which will be shown at the exhibition, are, in fact, described in another article in this issue (see page 739). Another firm which is introducing a mixer in this category is Winget, Ltd.; this firm will be showing a mixer known as the "Challenge." The mixer is of 4 cubic yards capacity, "with a proportionate increase in capacity when used as an agitator," the maker states. The mixing drum is inclined at 16 deg. downwards towards the front of the vehicle on which it is mounted, with a large charging opening so there is no sealed charging hopper. The direction of rotation of the drum is reversed to discharge its contents. Motive power for the drum is from a take-off at the front of the engine of the truck, which "provides an uninterrupted drive unaffected by gear change transmission when in normal operation."

A truck mixer of 6 cubic yards capacity or alternatively of 7¼ cubic yards when used as an agitator, is to be exhibited by Blaw Knox, Ltd. The design embodies a range of accessory equipment such as charging equipment and water systems, and even of the power drive, which are intended to be chosen to suit the particular operating conditions envisaged. The mixer to be seen at the exhibition will be mounted on a Leyland "Hippo" chassis, powered by a six-cylinder engine giving 125 b.h.p. at 1800 r.p.m.

Handling Aggregates

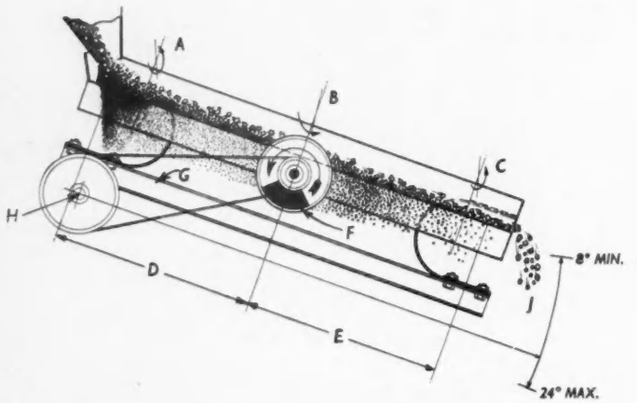
A mobile conveyor for loading or stockpiling granular materials, which incorporates vibrating screens at the delivery end of the conveyor, has been introduced by Frederick Parker, Ltd., of Leicester. It is known as the "Loadascreen," and is shown in use in the illustration below, from which its mode of operation will be quite clear. A range of sizes of this plant is envisaged with the main conveyor boom either 40ft or 50ft in length, and with conveyor belts from 18in to 36in in width. The boom may then be a box structure as illustrated, or a steel lattice. The power unit—either a petrol or oil engine or an electric motor—and the belt drives to the conveyor and the screening head may also be observed in the machine illustrated.

There is a simple wire winch device for adjusting the angle of the boom, which can be observed where the boom and the forward leg of the supporting "V" join, in the illustration; this device is replaced by a hydraulic ram in the larger machines. The boom can be lowered considerably and the screening head hinged back beneath the boom without disconnecting the drive when the "Loadascreen" is to be towed behind a lorry.

Separation into two or three fractions is achieved at the screening head, depending upon whether single deck or double deck screens are used. The screens are carried by steel channels, hinged at the conveyor boom, and supported also be chains hanging from a cross tree. A "pull lift" adjusts the inclination of the screens, and the chains are then held in cleats. The maker claims that the screens operate with "a skilful combination of gravitational and vibratory impulses to give maximum screening efficiency without 'dead spots' and with no waste vibration in the screen frame." In the diagram further explanation of this claim is given, for a single deck screen. The spring mounting of the screen frame is shown, together with the belt drive to the eccentric wheel. Out-of-balance motion is given by weights fastened to this wheel as indicated, and more or less out-of-balance weight can be simply obtained by putting on or taking off the segmental "weight flats" bolted to the wheel. For dry and freely screening materials, these weights, and, hence, the amplitude of vibration, are reduced, but are increased to a maximum for damp or "sticky" materials. Speed adjustment is thus unnecessary. Further adjustment is, however, given by the range of inclinations of the screens from 8 deg. to 24 deg.; in the 8 deg. to 12 deg. range, rotation of the out-of-balance wheel may be in the opposite sense to that indicated. With double deck screens the oversize material from the top screen is carried clear of the screening head by a plate inclined at about the same angle as the head itself, and further deflector plates separate the intermediate and fine fractions. It is possible to stop the conveyor belt, but vibrate the screens, thus clearing any clogged material before new supplies are fed along the belt. This is done with a head pulley clutch, which, like the other controls, is operated at ground level.

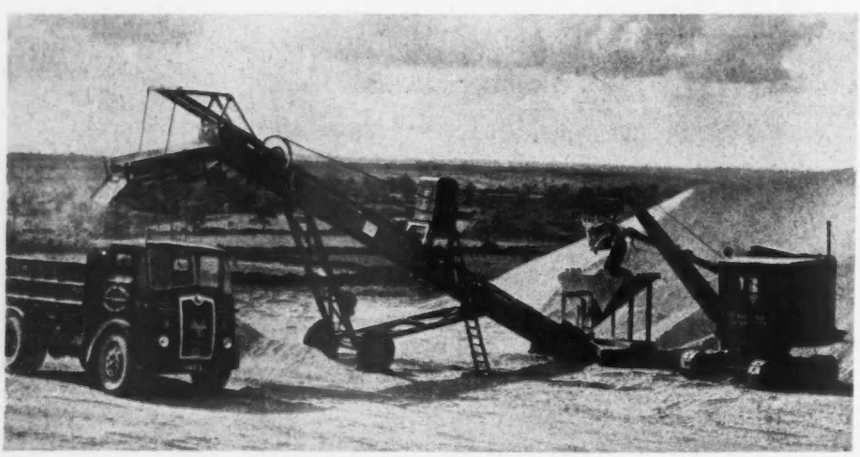
(To be concluded)

Loading shovel with a payload capacity of 10,000 lb



A—Elliptical motion here causes rapid stratification and eliminates critical bed depth. Oversize and nearsize particles move rapidly away to lower screening zone while free-screening particles are cleared in the upper screening zone.
B—Near-circular action here.
C—The elliptical motion here steadies the downward roll of the nearsize particles and arrests them in the lower screening zone.
D—Upper screening zone: free-screening particles quickly cleared.
E—Lower screening zone: nearsize particles arrested and sieved.
F—Weight flats for adjusting amplitude.
G—Frame: remains steady in operation.
H—Pivot point.
J—Oversize removed.

Screening head of the "Loadascreen" conveyor



The "Loadascreen" at work in a Leicestershire quarry

1958 Motor Show

No. II—(*Concluded from page 678, October 31*)

Foreign Cars

TURNING now to the foreign exhibits, our attention was forcibly attracted by the impressive display of the latest cars from the United States and from Canada, some of them 1959 models which will not be shown in America until the opening of the New York motor exhibition later this month. Whenever we have the opportunity of viewing this sector of the London show, we feel at loss to describe adequately their technical features ; anyone not entirely familiar with American cars will find it difficult to distinguish between the merits of the various makes without making a close study of their specifications, a study which—in absence of "exploded" models and by the lack of technical information on the part of the exhibiting agents—sometimes fails to reveal the relevant details. It appears that American manufacturers take technical perfection so much for granted that they are quite satisfied to impress the public almost entirely by styling changes and by offering such superlatives as still bigger cars, more powerful engines and servo assistance for practically everything. For this reason the average visitor, and frequently even the expert, fails to appreciate the fineness of American detail design and is inclined to regard the latest cars as just another creation of Detroit fashion designers.

In view of the considerable number of American cars on show, comprising about two dozen different models, it is not possible to give even a short description of their main technical features, and we must confine ourselves to a brief survey of the current trends which govern the general layout and the appearance of the popular American models.

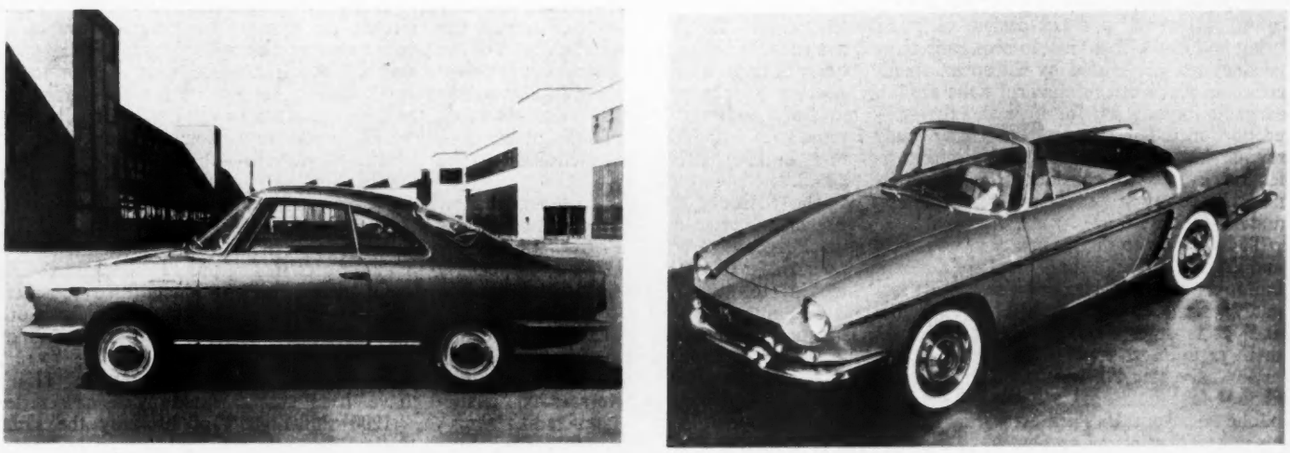
Taking the bodywork first, one has the impression that the stylist's ideal can be summed up in a few words : longer, wider, lower with still more glass, sharper tail fins and more ostentatious ornamentation.

The biggest "prestige" cars like Cadillac and Lincoln are close to 19ft long, about 6ft 8in wide and only 4ft 9in high ; they weigh dry about 45 cwt. Even the less expensive models, like the six-cylinder Chevrolet "Bel Air," have an overall length of 17ft 7in and a height of 4ft 9in, i.e. about the same height as such small European cars like the Austin "A.35" or the Fiat "600." The most amazing aspect of the American body design is the misproportion of the passenger space relative to the overall dimensions ; in order to provide inter-axle seating accommodation at a set wheel base of something between 10ft 6in and 11ft only one-third of the total length of the car is utilised as passenger room, while the remaining two-thirds are equally divided between the engine compartment and the luggage boot. The ground clearance is about the same as that of an average European car, with the result that the propeller shaft tunnel protrudes far above the floor level ; the low roof line and the receding pillars of the panoramic windscreen badly interfere with the entrance and even more with the exit.

It seems that appearance has to compensate the customer for any appreciable lack of real comfort. The new styling changes are difficult to describe in the sober language of the engineer, and so we can only quote from publicity hand-outs that a "new treatment of both front and rear, side and roof, introduces a dramatically new concept of striking exterior styling." Some models "achieve an entirely new front-end effect with upward and outward, sharply flaring wing eyebrows, whilst the rear-end styling is highlighted by new flared fin treatment and jet-tube tail-lighting design." The only visible reminder of the jet age seemed to us the individual "ejector" seats, i.e. individual seats for the driver and front passenger which, by operating a lever, swivel outward in a 40 deg. arc, thus making for easy entry and exit.

The most extraordinary feature of American automobile engineering is the high power requirement of cars which, in the last five or six years, has gone up from an average of 100 h.p. to more than 250 h.p. This demand for an increased horsepower, to a certain extent, is a result of the now almost generally adopted hydrokinetic transmission which, in order to be really useful, not only requires a higher engine output, but also a higher torque than a mechanical transmission. Other reasons are the growing demand for power-assisted steering and brake operation, but the main cause of the higher power demand is the rather exaggerated attention paid by American drivers to "acceleration." Although a very high acceleration can very rarely be utilised in American traffic conditions, the demand for higher horsepowers, suitably propagated by extensive publicity, has arisen, and the size and output of the engine now constitutes an important sales point. The vast majority of manufacturers are making vee eight-cylinder engines between 4·5 litres and 6·5 litres capacity, ranging from 180 h.p. to 300 h.p. (the biggest American car engine is that of the Lincoln, with a capacity of 7 litres and an output of 375 h.p.). The higher output has primarily been effected by increasing the cylinder capacity but supplemented in every case by a corresponding raising of the compression ratio and, frequently, of the engine speed.

The average compression ratio lies between 9 : 1 and 10 : 1 (with a maximum of 10·5 : 1), as 100 octane is taken for granted in U.S.A. and because the automatic transmission effectively limits excessive full-throttle operation of the engine. Fewer engines now employ the hemispherical combustion chamber, since investigations in the mechanism of combustion have shown that smoother running can be promoted by wedge-shaped combustion chambers without any appreciable loss of volumetric efficiency. Fuel injection is still in its infancy, although the Chevrolet "Corvette" sports car can be equipped with the G.M. injection system.

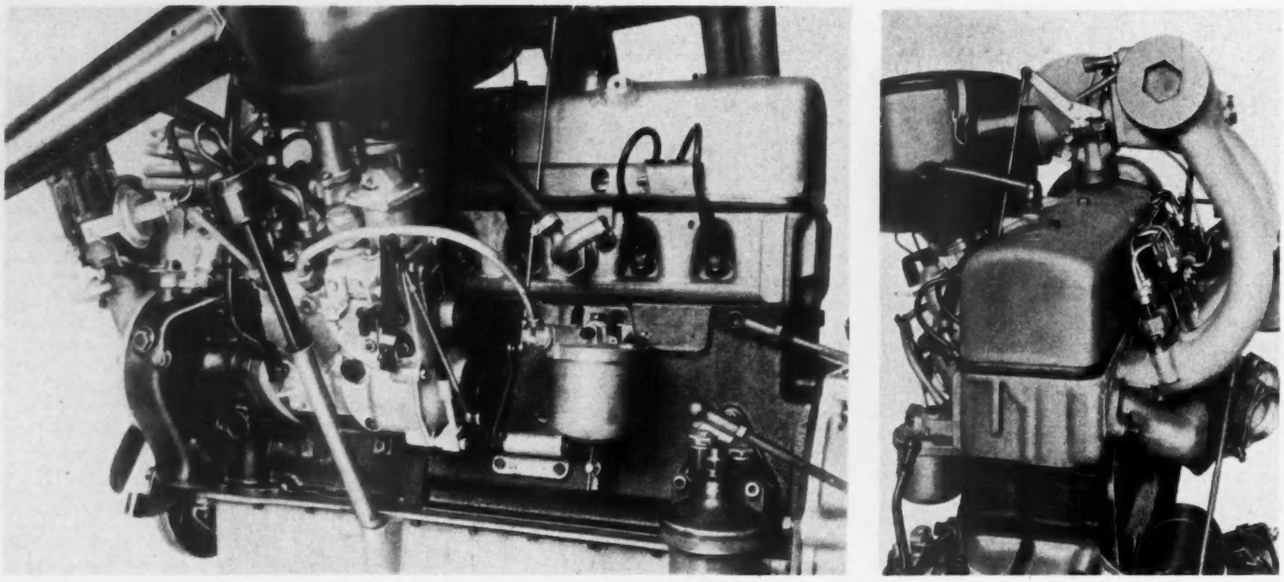


The aerodynamic N.S.U. "Sport Prinz" (left) contrasts strongly with the angular open body of the Renault "Floride" (right)

There is little to report about changes in transmission design. Because of the higher torque of the latest, more powerful engines and of the improved efficiency of torque converters at higher conversion ratios, it has been possible to reduce the planetary gearing in some transmission systems from three gear trains to two trains.

Front suspension generally follows the conventional pattern of having wishbones of unequal length in conjunction with coil springs, in some cases with torsion bars (Chrysler Corporation). The rear axle, in all cases live, is mostly supported by semi-elliptic leaf springs or, less frequently, by coil springs in combination with radius arms. Air springing is optionally available on some cars of the General Motor Corporation ; Chrysler offers pneumatic helper springs with levelling valves as optional equipment, as illustrated.

The critic, looking under the bonnet of an American car (a procedure which, as already mentioned, was not greatly encouraged by



Pump (left) and injectors (right) of the 130 h.p. " 220 SE " Mercedes engine

the salesmen at the show) will always be impressed by the capacity of its designer to achieve an optimum technical effect with comparatively simple means or, to put it more concretely, to build a smooth and silent running, reliable power unit without resorting to the necessity of super-fine machining operations. This, of course, is done by careful attention to detail design, all parts being laid out with a view to economic mass production. Measured by European standards, the American mechanical units are not as good looking as, for instance, the well-proportioned Italian ones, but closer study reveals that any apparently æsthetical imperfection is due to considerations primarily necessitated by requirements of machining and assembling.

Turning now to the French cars, we expect and do indeed find a fundamentally different outlook. The French designers, even those in American controlled factories, are first and foremost creative artists who conceive their creation as a whole without, in the preliminary stage, being too much worried about considerations of production and public sales appeal. Their art is, however, by no means *l'art pour l'art*, but is well-backed by solid scientific understanding of the technical problems involved. French constructions are, as a rule, original, bold and sometimes actually ingenious, and well-designed with an instinctive consciousness of functional beauty. For this reason the mechanical layout as well as the styling of the representative French makes is generally remarkably good.

A typical example of French design is the well-known 850 c.c rear-engined Renault " Dauphine," a car which, since its introduction two years ago, has become France's best selling car at home as well as in export markets, especially in the United States. The car, at present made at the rate of 1400 units a day, has not entirely replaced the smaller 750 c.c. model, which appears to be still popular in France.

A beautiful, Italian-styled model, " Floride," a two-seater coupé mounted on the underbody of a " Dauphine," was the centre of attraction at the Renault stand. The 2·1 litre " Frégate " four-seater saloon, characterised by a fluid coupling and independent suspension at the front and rear, continues for the following year with only minor modifications.

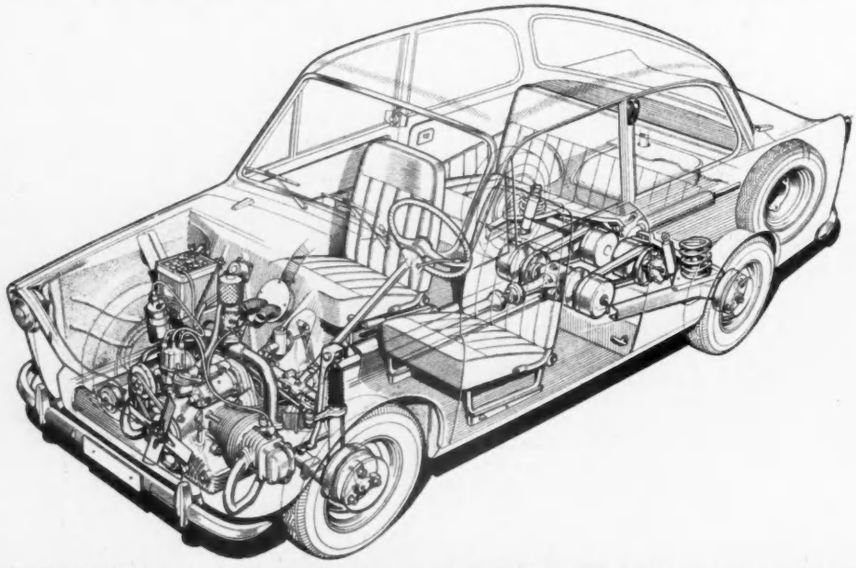
Citröen, apart from showing the well-known " D.S.19 " with the ingenious hydro-pneumatic suspension, also displayed the "I.D.19." The "I.D." type is basically similar to the "D.S.," but the 1·9 litre four-cylinder o.h.v. engine, having a lower compression ratio, develops only 60 h.p. (instead of the 75 h.p. of the " D.S.") at the same speed of 4500 r.p.m. The main difference between the two models is the simplified equipment of the type " I.D.," as such refinements as power steering and braking, the hydraulic operation of clutch and gear shift, and the load-responsive adjustment of the front and rear braking effort are exclusive to the " D.S."

The Simca " Aronde," another popular French car, remains unaltered and so does the Peugeot " 403." The latter, although by no means a very " modern " car, particularly seemed to attract students of automobile engineering, probably because of its combination of old and novel engineering features. The independent front suspension has wishbones and a transverse leaf spring, while the rigid worm-drive rear axle is supported by coil springs and radius arms ; unusual for a car weighing dry 23 cwt is the use of a rack-and-pinion steering box. The 1·47 litre four-cylinder engine is also quite interesting, having detachable wet cylinder liners and hemispherical combustion chambers with pushrod-operated inclined valves ; it develops, at the moderate compression ratio of 7 : 1, 58 h.p. at 4900 r.p.m.

Generally speaking, it seems that the French designers in their engines employ a lower compression ratio than their colleagues on the Continent. Also, there appears to be little interest in France for full-automatic transmissions and overdrives, though most French cars are optionally equipped with electro-magnetic clutches.

The Italian automobile industry this year was again represented by the four firms, Alfa-Romeo, Ferrari, Lancia and Fiat. The latter firm is the only Italian manufacturer making cars in large scale production, and, consequently, their products differ considerably in layout and styling from the more specialised sports and fast touring cars of the other three factories.

The Fiat 1·1 litre cars of the type "1100" have been supplemented by a new series " 1200 Full-Light " of basically the same design, but powered by a bigger 1·22 litre



A " D.A.F." in section : notice the use of the front spring to afford track control, and the mounting of the steering arms well clear of the wheels

engine of 72mm bore and 75mm stroke which develops 55 h.p. at 5300 r.p.m. against 43 h.p. at 4800 r.p.m. of the 1·1 litre engine. The new engine has overhead valves with twin springs for inlet and outlet, an aluminium cylinder head with separate ducts to each cylinder, and main bearings and big-ends of copper-lead-indium alloy. In contrast to the type " 1100," the car has a two-stage propeller shaft with a centre bearing.

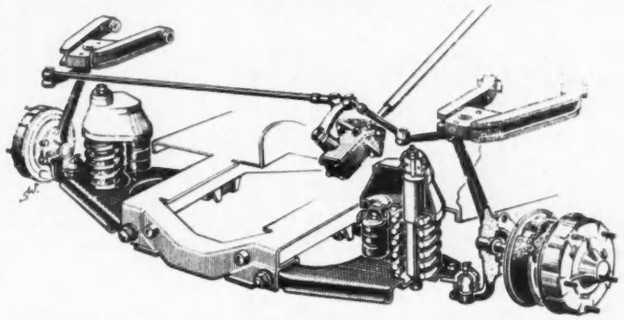
The two small rear-engined car types " 500 " and " 600 " remain unaltered ; the water-cooled 600 c.c. models are known to sell well in Italy and abroad, while the popularity of the 500 c.c. air-cooled twin-cylinder car is mainly confined to the home market.

All the smaller cars of Fiat, including the 1·1 litre class, have a rather utilitarian character and show little of the sophisticated and extremely refined lines generally associated with the designs of the Italian body stylists. They are, however, well proportioned, sufficiently attractive, and have a functional beauty which might well outlive some of the more extravagant body styles dictated by pure fashion trends.

Italian design at its best was to be seen at the stand of Alfa-Romeo where public attention centred around the new 2000 " Spider," a very well styled two-door 2/4-seater fitted with a 1·98 litre four-cylinder engine of 84·5mm bore and 88mm stroke. The engine, like that of all other Alfa-Romeo cars, has hemispherical combustion chambers and inclined valves, operated by twin chain-driven overhead camshafts, two twin-choke carburetters, and five main bearings ; with a compression ratio of 8·5 : 1 it develops 115 h.p. at 5800 r.p.m. The aluminium gearbox incorporates five ratios with direct drive on the fourth speed. The front suspension employs wishbones and coil springs with a stabiliser ; the live rear axle is also supported by coil springs, and the thrust and the torque reactions are taken by an upper triangular bracket and lower radius rods. The heavily finned brake drums are of light metal.

The well-known " Giulietta " models of Alfa-Romeo were also worth studying ; their basic design principles are similar to those incorporated in the above-mentioned " Spider." Remarkable is the performance of the 1·29 litre engine of the " Giulietta " " Sprint Veloce " version, which has a compression ratio of 9·5 : 1 and develops 90 h.p. at 6000 r.p.m.

The Lancia 1·1 litre and 2·5 litre models " Appia " and " Aurelia " remain with some minor modifications only. There is, however, a more drastically redesigned version of the type " Flaminia," displayed as a five-seater, four-door saloon with a 2·46 litre, 100 h.p., 60 deg. vee six-cylinder engine. This car is remarkable in as far as it breaks away from the old-established Lancia practice of having the kingpins of the coil-sprung front wheels slidably mounted in parallel sleeves. This rather outdated system has been replaced by the now generally accepted layout of wishbones of unequal length in conjunction with coil springs and concentric dampers, supplemented by a stabiliser bar.



Another thoroughly unusual front suspension is that of the Goggomobil " Royal " : leading arms locating the upper ball joints allow a simplified steering linkage

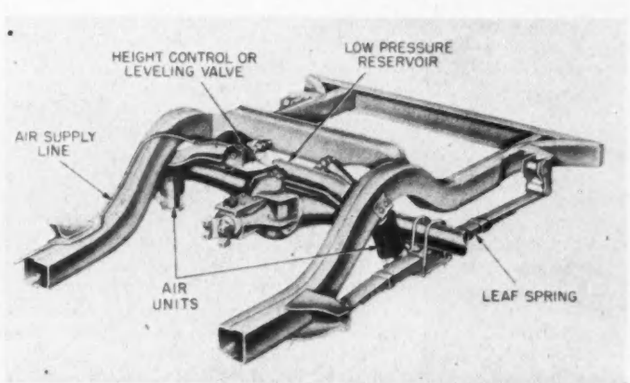
The most powerful Italian car is the Ferrari " Gran Turismo " two-door coupé, a very fast sports-touring car (157 m.p.h. is specified), powered by a 2·95 litre 60 deg. vee twelve-cylinder engine of 70mm bore and 58·8mm stroke. Each bank of cylinders has its own single overhead camshaft to operate inclined valves. The engine has three carburetters, a compression ratio of 8·5 : 1, and develops 240 h.p. at 7000 r.p.m. The multi-tubular chassis has an orthodox wishbone-cum-coil spring front suspension and a live rear axle with semi-elliptic leaf springs.

The German cars at Earls Court are generally identical with those exhibited at last year's Frankfurt motor show and to a great part, have already been described in THE ENGINEER of September 27, 1957.

The most interesting refinement, added to the Mercedes-Benz type " 220 S," is the replacement of the carburetter by a new fuel injection system which differs basically from the principle originally used in Mercedes racing cars and in the Mercedes 3 litre car, type the " 300." It was displayed in the Mercedes-Benz 2·2 litre saloon type "220 SE," a car of the conventional Mercedes swing-axle design, fitted with a six-cylinder overhead camshaft engine of 80mm bore and 72·8mm stroke.

In contrast to the injection system of the type " 300," where the injection to each inlet port is effected by a corresponding pump element and is phased to coincide with the opening of the inlet valve, the injection of the " 220 SE " engine takes place independently of the valve timing. A metering pump, in principle similar to that of the well-known Bosch injection pump, but having only two plungers, is employed, and each individual pump element supplies simultaneously the injector nozzles of three cylinders. There is no synchronising distributor, and the fuel, injected into separate branches of the inlet manifold a short distance before their joint with the cylinder head at a pressure of about 215 lb per square inch, is being deposited inside the inlet port in a more or less atomised state, before being induced into the cylinder at the opening of the valve. It is obvious that the fuel discharge into the branches of the air-intake manifold is intermittent, being effected by a reciprocating pump, but the phasing is not directly connected with the final induction, which is entirely controlled by the valve timing.

The other difference between the two injection systems is the delivery control. In the 3 litre engine the volume of the injected fuel is controlled by a diaphragm in response to the vacuum in the intake manifold. In the 2·2 litre engine the control lever of the injection pump is mechanically connected with the accelerator linkage; a cam, attached to the control lever, operates a further linkage to the throttle behind the air-intake filter, so that, at any given constant engine speed, the volume of fuel injected and the setting of the throttle are determined by the position of the " gas pedal." In addition to this arrangement, there is a centrifugal governor fitted to the camshaft of the pump which acts upon the pump control-rod so that, at variable engine speed, the delivery volume is adjusted in response to the engine speed as well as to the setting of the air throttle. This control layout has the advantage that the amount of fuel and air are simultaneously adjusted ; the engine responds to the position of the gas pedal without any appreciable time-lag and without requiring any accelerating device in the injection pump. When the gas pedal is released, the governor sets itself to the " stop " position, so that no fuel is injected ; fuel delivery, however, is restored whenever the engine speed drops below 1500 r.p.m.



The 1959 Dodge " Custom Royal " hardtop ; notice that there are four doors. The 361 cubic inch engine has a compression ratio of 10 : 1. Optional on this and other Chrysler models is the self-levelling rear suspension (right)

The pump, as already mentioned, is a two-cylinder unit, running at half engine speed, and the camshaft has two symmetrical cams for each plunger, thus effecting two injections per pump element and camshaft revolution, or one from each element for each engine revolution. Each pump element feeds a group of three calibrated jets, assembled in a "divider box," each of which supplies a group of three engine cylinders. Fuel pipes lead from the divider box to the individual injector nozzles placed in the separate branches of the air intake. As the working cycle of each cylinder stretches over two engine revolutions, it is seen that each group of cylinders receives two injections per cycle, and that these injections are entirely independent of whether the inlet valve of one individual cylinder is opened or closed. The injection, therefore, though actually intermittent, has in effect a similar character to the continuous injection of some U.S.A. injection systems.

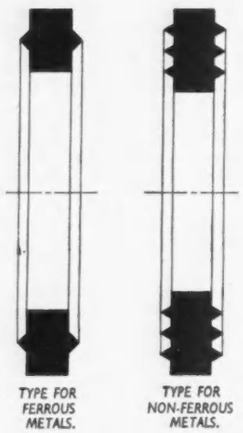
Apart from the above-mentioned centrifugal governor of the pump, there are further thermostatic or pressure-sensitive control elements for the purpose of modifying the fuel delivery in response to the temperature of the cooling water and, further, to the temperature and the density of the intake air. An electromagnetic control enriches the mixture automatically for starting in cold weather conditions.

Compared to the standard two two-barrel carburetter engine of the type "220," the fuel-injection engine of the type "220 SE" (which has the same compression ratio of 8·7 : 1, but a slightly different valve timing) has a maximum torque of 146 lb ft at 3800 r.p.m., against 137 lb ft at 3600 r.p.m., i.e. a gain of about 9 per cent over the whole speed range; the maximum output amounts to 130 h.p. at 5000 r.p.m., against 120 h.p. at 5200 r.p.m. of the carburetter engine. In view of the considerable mechanical effort involved, this increase might appear rather moderate, but it is stated that a further raising of the output has been deliberately avoided and the higher performance is solely used to improve the acceleration and the flexibility of the car.

Making its first appearance at the show this year was N.S.U., Europe's biggest motor-cycle factory, which showed an attractive small four-seater saloon, "Prinz." The standard version of this car, fitted with a rear-mounted 600 c.c., fan-cooled, twin-cylinder, four-stroke engine, is identical with the one described in our 1957 Frankfurt show report, but there was also a new, well-styled, two-seater sports saloon which differs from the standard car by a higher final-gear ratio and a "hotted-up" engine. The engine, like the normal version, has hemispherical combustion chambers in a light metal cylinder head and inclined valves operated by rockers from an overhead camshaft, which is driven from the crankshaft by means of eccentrics and connecting-rods. It has the same compression ratio of 6·8 : 1, but develops 30 h.p. at 5000 r.p.m., compared with 20 h.p. at 4000 r.p.m. of the standard engine.

The two Isetta types "300" and "600" have already been shown at last year's exhibition and remain unchanged apart from some minor modifications. The Isetta 300 c.c. "bubble-car" already fairly popular on German roads is now available (though not displayed at the stand of Isetta of Great Britain, Ltd.) as a three-wheeler, a conversion which in Britain leads to a diminution in the rate of purchase tax levied, and also to a reduction of the annual licence fee. Further, if the reverse gear is rendered ineffective, the tricycle can be driven with a motor-cycle licence.

Goggomobil, Ltd., the concessionaires for Great Britain of Hans-Glas G.m.b.H., besides showing the fairly well-known miniature cars fitted with rear-mounted, air-cooled, two-stroke engines of 300 c.c. and 400 c.c., exhibited a new, considerably bigger, model, the Goggomobil "Royal," a pleasantly styled four-seater saloon in all-steel integral construction. The car is powered by a front-mounted 682 c.c. opposed two-cylinder engine of 78mm bore and 72mm stroke which, at a compression ratio of 7 : 1, develops 30 h.p. at 4900 r.p.m. The twin-carburetter engine has hemispherical combustion chambers in light metal cylinder heads and pushrod-operated inclined valves; the cowled cast-iron cylinders are cooled by a fan mounted at the front end of the crankshaft. A prototype of this



All-metal high-pressure sealing washers

car, shown at last year's Frankfurt motor show, was designed as a front-wheel drive car with the gearbox and final-drive casing bolted to the clutch housing. This, from a technical point of view, entirely logical arrangement has been abandoned in favour of a different layout in which the torque from the engine is transmitted via a four-speed, all-synchronised gearbox and a propeller shaft to a conventional live rear axle. The front suspension employs coil springs in conjunction with pressed steel lower transverse wishbones and upper longitudinal radius arms, while the rear axle is carried in semi-elliptic leaf springs. Telescopic double-acting telescopic dampers are fitted at the front as well as at the rear, and additional hollow convolution rubber buffers provide a progressive spring characteristic.

The Goggomobil "Royal" is unique among European cars of less than 1 litre cylinder capacity as being the first car, designed in the last twenty years, which not only separates the engine-gearbox unit from the final-drive casing, but also employs a live rear axle, i.e. a design principle which, for small cars, is generally regarded as outdated on the Continent.

The first Dutch motor-car ever displayed at a British motor show is the "DAF" small car made by Van Doorne's Automobielfabriek of Eindhoven, a big firm which in the past has been mainly known as a manufacturer of heavy commercial vehicles and trailers. The car, at present, is still a prototype but, after the favourable reception of these interesting models at this year's motor shows in Amsterdam and Paris, plans have been drawn up for a large-scale production starting next spring with the ultimate aim of making 200 vehicles a day. This optimistic forecast is based on the undeniable fact that the "DAF" offers possibilities never before materialised in a small and comparatively inexpensive car, namely, a full-automatic transmission which employs only a gas pedal, a brake pedal and a forward-reverse lever as its primary controls.

The principle of the "DAF" transmission, based on the stepless variation of the transmission ratio by a "V" belt running over two alternatively expanding or contracting conical pulleys, is not novel in itself and is still being used in the small German D.K.W. motor-scooter "Hobby." New, however, is the application of this system for transmitting a torque of about 60ft-lb to the sprung rear axle shafts of a car, and the design of the automatic control mechanism which shows a more than usual degree of engineering skill and is worthy to be studied in detail.

The "DAF" car is an attractive four-seater saloon built in integral all-steel construction; the floor is reinforced by a central box section. The front wheels are suspended by means of a low-slung leaf spring with two telescopic dampers mounted on each end which serve as king-pins. The steering arms are integral with these king-pins and are operated by a two-piece track-rod from the rack-and-pinion type steering box. At the rear the half-shafts of the independently sprung wheels are supported by coil springs in conjunction with telescopic dampers, the thrust and the reaction moments being transmitted to the body structure by two pressed steel structures.

The car is powered by a 590 c.c. front-mounted fan-cooled, two-opposed-cylinder, four-stroke, o.h.v. engine of 75mm bore and 65mm stroke; it has a compression ratio of 7 : 1, an output of 22 h.p. at 4000 r.p.m., and such features as light metal cylinders with cast-iron liners, light metal cylinder heads and lead-bronze bearings for the big-ends of the connecting-rods.

The engine torque is transmitted via a simple centrifugal clutch (having no additional withdrawal mechanism) and a propeller shaft to a transfer box. The latter connects the propeller shaft by bevel gearing with a perpendicular cross shaft carrying the two front pulleys of the belt drive, and also serves as a reverse gear. For this purpose the bevel pinion, keyed to the propeller shaft, is running in constant mesh with two crown wheels, both of which are free to rotate on the transverse drive shaft in opposite direction, but can be positively coupled to the latter by a sliding dog clutch. Shifting the dog clutch by a short lever from its centre position (neutral gear) alternatively to the right or to the left selects forward or reverse.

The above-mentioned pulleys are keyed to the transverse shaft on either side of the transfer box, and each pulley is linked by a "V" belt with a corresponding pulley attached to one individual unit of the swing axle structure. The front as well as the rear pulleys are split in the rotational plane, one half being keyed to the shaft while the other one is free to slide on spines in axial direction; the variable distance between the two halves determines the effective pitch diameter of the pulley relative to the "V" belt.

In case of the driving front pulleys the axial displacement of the sliding half-pulley is effected by the thrust caused by the centrifugal force of bob weights rotating with the pulley; at the rear the sliding half of the pulley is loaded by the pressure of a coil spring. When the car is set in motion, the front pulleys present a small effective diameter to the "V" belts, while the rear pulleys present a large diameter. As the engine revolutions increase, the centrifugal force of the bob weights tends to push the two halves of the front pulleys together, thus increasing their

effective diameter. The belt is forced to run on a longer circumference and, having a constant length, is pulled on to a smaller diameter in the rear pulleys. This pull overcomes the loading of the coil springs mounted in the rear pulleys to keep the belt under tension. As a result of the differential variation of the effective pitch diameter in the driving and in the driven pulleys, the transmission ratio increases automatically with the engine speed. On the other hand, if the belts are called upon to transmit a higher torque, they move to a larger diameter on the rear pulleys, accompanied by a corresponding reduction of the effective diameter of the front pulleys ; the transmission ratio is lowered.

It is seen that the "DAF" system, named "Variomatic" because of its continuously variable transmission ratio, is primarily responsive to the engine speed. There is, however, an additional vacuum control which can be used at will either to assist or to retard the centrifugal effect of the rotating bob weights. For this purpose the front pulley assemblies are fitted with vacuum cylinders, and vacuum from the inlet manifold can be applied alternatively to one or the other side of a diaphragm by means of a control valve mounted at the dashboard ; the amount of the vacuum available depends on the position of the gas pedal.

In one position the vacuum, assisting the centrifugal action, can be used to allow quiet cruising with a larger throttle opening at a high transmission ratio. In the other position, the vacuum, opposing the centrifugal effect, automatically selects, at completely closed throttle, a low transmission ratio and utilises the braking effect of the engine on a descent.

Because of the separate drive to each individual rear wheel the "DAF" car is not fitted with a differential. The problem of how to transmit the torque from the body-mounted front pulleys to the pulleys on the swing axle structure without any excessive distortion of the belts has apparently been solved quite satisfactorily. The axes of the oscillating suspension units are located so that they coincide approximately with the tight side of the belts, with the result that the latter are not greatly affected by the spring movements of the wheels. A minor lateral deflection, of course, is unavoidable, but this occurs on the slack side of the belts, which are claimed to be sufficiently flexible to take up considerable wheel movements. Remarkable in the design of the rear axle layout is the reduction gearing, which is interposed between the rear pulleys and the drive rear shafts ; it is purposed to reduce the torque which has to be transmitted through the belts, and to allow for a greater ground clearance (7in)

Although the revival of the old friction drive, even in modified form, will appear strange to the automobile engineer, it must be stated that the general principles incorporated in the design of the "Variomatic" transmission are thoroughly sound. With the greatly improved moulded "V" belts now available, the transmission should prove as reliable in severe service conditions as it has apparently done in prolonged road tests.

Components and Accessories

There appeared on the stands of Lockheed and Remax relays to increase the pressure in the brake hydraulic system. The need for such devices originated with the use of disc brakes with the disc driven at the inside, in which little work but very high forces are needed to obtain the design brake torque ; using a small master cylinder or a long brake pedal is not a satisfactory solution because any unexpected increase in the clearance between disc and shoe will cause extreme delay in obtaining braking. However, the pressure multiplier is, quite obviously, applicable to drum brake systems, and will reduce the pedal effort needed for a given retardation or increase the maximum torque available, if that is the limiting parameter of the braking performance.

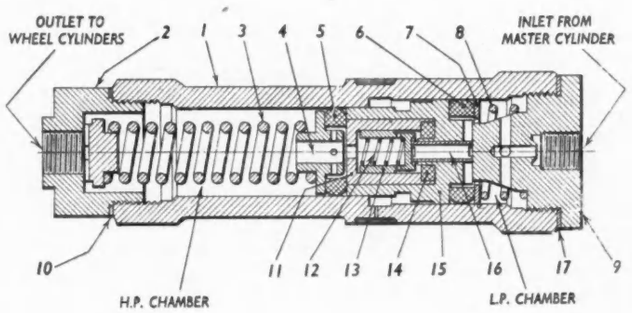
We illustrate the Baldwin "F.B." booster; the compound piston runs in a large low-pressure cylinder and a small high-pressure cylinder, and includes passages between the cylinders which can be closed by a valve. This valve is held open, when the piston is displaced to the right, by a fixed push-pin. When the pressure in the master cylinder rises high enough for the difference in forces on the large and small faces to move the compound piston against the reaction spring—roughly 150 lb per square inch, enough for the brake clearances to have been taken up—the piston will move and the valve close. From this stage on, the pressure in the outlet will increase faster than that at the inlet.

The Pioneer Oil Sealing and Moulding Company, Ltd., displayed a new seal for high-pressure applications which is expected to have a particularly good high-temperature performance. It consists of a washer of hardened steel, on each face of which there is a ring with a sharp apex. On tightening a joint, these rings bite into the opposing surfaces to form a metal-to-metal seal. For use with hard materials only one ring is formed, for softer materials a plurality. The two faces are identical, so that a washer can be turned over without prejudice to sealing on reassembly. If the radial clearance for the washer is less than half the width of the raised ring, there is no risk of the ring failing to enter its original seat.

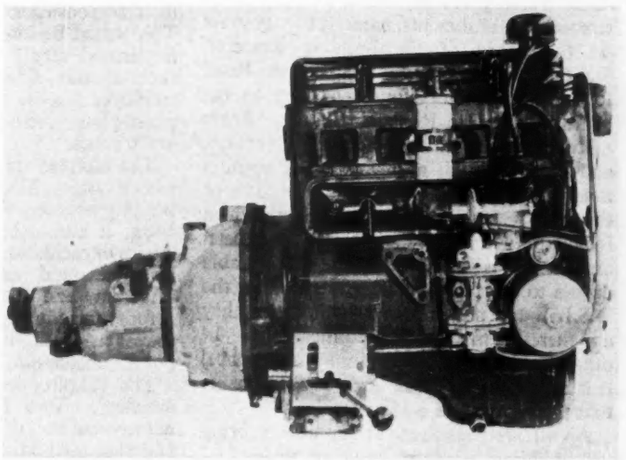
Development work has, we are advised, proved these seals for pressures between 40,000 lb and 60,000 lb per square inch. Standard washers of 100-ton steel will operate up to 250 deg. Cent., and tungsten alloy steels will extend this to 500 deg. Cent. It is intended to market a selected range of British Standard Pipe sizes.

Bristol Cars, Ltd., has designed a marine reversing gearbox, particularly for high-speed motor boats, which is claimed to be much smaller and lighter than other units of the same duty—135ft-lb torque, or 100 s.h.p. at 500 r.p.m. It follows car practice in using the same clutch for ahead and astern running, but whereas on a car first and reverse gears are usually engaged with a crash, this box uses Borg-Warner inertia-lock synchromesh clutches. An electrical sensor detects movement of the gear selector between ahead, neutral, and astern, and disengages the clutch by means of a vacuum servo motor. Re-engagement when the new position is reached is regulated by restricting the admission of air. Clutch slip is minimal because the control unit allows changes only at idling throttle ; an early version is illustrated, and it can be seen that, in accordance with aircraft practice, thrust is increased by moving the power lever in opposite directions for forward and reverse. Reverse thrust is restricted to about 20 per cent full throttle to avoid swamping a high-powered craft.

The gearbox, which incorporates engine mountings, is cast in corrosion-resistant "L.33" light alloy. A large bearing is included in the output end to accept full thrust, both ahead and astern. The reversing train is a bevel gear epicyclic cluster, similar to a car differential. Lubrication is by oil splash ; the complete unit is sealed, with a non-return pressure relief valve as a breather. When the gearbox cools, air is drawn in past the front oil seal ; if the engine clutch casing is airtight, air will be sucked through the crankshaft rear oil seal.



1—Brake booster body.
2—High-pressure chamber plug.
3—Reaction spring.
4—Seal ring thrust member.
5—High-pressure chamber ring seal.
6—Low-pressure chamber ring seal.
7—Spring thrust washer.
8—Sealing ring compression spring.
9—Low-pressure chamber plug.
10—Plug washer.
11—Valve carrier.
12—Valve spring.
13—Valve.
14—Valve sealing ring.
15—Compound piston.
16—Valve push pin.
17—Plug washer.



(Left) Hydraulic pressure booster. (Right) The Bristol marine gearbox follows car practice in using a single friction clutch and synchronised dog clutches. The friction clutch is operated by depressed air : the exhauster can be seen below the fuel pump of the "Consul" engine

LETTERS AND LITERATURE

Letter to the Editor

We do not hold ourselves responsible for the opinions of our correspondents)

MINISTRIES AND THE D.S.I.R.

SIR,—My attention has been drawn, unfortunately somewhat belatedly, to your article of August 29 on " Research and Accountancy," in which you make particular reference to the report of the Select Committee on Estimates to the House of Commons about the work of the D.S.I.R.

I have had, I am glad to say, the opportunity of gathering considerable experience in the working of three of the many D.S.I.R. research establishments, namely, twenty years on the board of the Building Research Station, five years on the board of the Road Research Laboratory, and ten years on the board of the Fire Research Station. From this experience I entirely endorse your article, and I must give it as my personal opinion that the undoubted successful operation of the three research establishments with which I have been fortunate enough to have been associated, is due in some considerable degree to the fact that they work under the D.S.I.R. and not under any Ministry ; they are therefore free of any political bias. In other words, as I have said more than once, it is a blessing to those three establishments that they never had a Minister.

An attempt was made at one time to bring the Building Research Station under the ægis of the Ministry of Works. This was successfully opposed and I was glad then to have the opportunity of supporting that opposition as strongly as I possibly could. It was fortunate that the proposal was turned down ; research and politics do not go well together.

G. M. BURT

London, S.W.1,
October 22, 1958.

Book Reviews

Engineering Vibrations (With Applications to Structures and Machinery). By L. S. JACOBSEN and R. S. AYRE. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 77s. 6d.

VIBRATION is important and its principles are therefore taught in universities and technical colleges. One result of this has been the appearance, in recent years, of a rash of elementary books on the subject. Although the quality has varied enormously from book to book, these new arrivals seem all to have covered much the same ground in much the same way. In fact, it is scarcely an exaggeration to say that all seem to have borne a marked resemblance in this respect to some excellent forerunners ; but few have come anywhere near the latter as regards lucidity, dependability or readability.

In short, the time has come for a " New Look " in textbooks on vibration (just as it has for Structures and Strength of Materials books). It is not a fact that the only way to teach this subject to an honours student is to deal first with one degree of freedom, then to consider a damped oscillator, then to turn to undamped systems with n degrees of freedom, and so on. Professor W. J. Duncan's *R. and M.* 2000, for instance, contains an excellent alternative introduction to this subject—admittedly not for students, though it can be simplified quite easily. There is still ample room for an elementary book with a genuinely fresh approach to vibration theory and the book under review comes close to being one, although it does preserve the familiar order of battle.

The first half of the text deals with systems having one degree of freedom. It is concerned with free and forced oscillations of conservative and damped systems, with energy methods and with non-linear vibrations. The treatment of forced oscillation includes consideration of transient excitation. This would be difficult (or, at least, clumsy) if pursued very far in an elementary book such as this if analytical techniques were employed ; as it is, the authors use simple phase-plane methods for the purpose, to great effect.

The chapter on energy methods encompasses systems having infinite freedom. This is a pity because, being in the first part of the book, it comes before the introduction of modes of oscillation. To deal with Rayleigh's Principle (and in this book Southwell's Theorem and Dunkerley's Method too) before introducing the notion of modal shapes is—well, intrepid. But there, it is not an uncommon thing to do.

The chapter on non-linear oscillation is excellent. Two techniques are employed, namely the use of the phase-plane and the Galerkin method. The authors prefer to call the latter " Ritz's Averaging Method " (as opposed to " Ritz's Minimising Method ") because it was the German who first proposed it ; Ritz proposed both methods, it seems, and then went ahead with only one, thereby backing a loser. Surely it is quite usual to reward the backer of a winner. This method, whatever it is called, has its basis in the variational calculus so that the authors of this book (which is pitched at quite a simple level mathematically) have had to devise a fresh approach. Naturally enough, something is lost in this process—but the arguments used are quite clear and fairly persuasive, if lacking in beauty. The chapter on non-linear vibration is a remarkable piece of work.

The first part of the book probably contains as good a treatment of single-degree-of-freedom systems as there is. The second deals with multi-freedom systems, and it gives an excellent, though simple, introduction to the subject. Damping is not dealt with, nor is non-linearity, nor is transient excitation (to any important extent, anyway). In short, the authors do not leave themselves scope in the second portion for the *finesse* of Part One.

There are many numerical examples in this book, some with answers given. There are also summaries at the ends of the chapters. Again there is an immense bibliography at the end of each chapter. But some of the papers mentioned are not so very wonderful, as is the case with foundation vibration for instance ; moreover some important articles are omitted (again as in foundation vibration). Finally there are three appendices on Instrumentation, Graeffe's Method and a Supplementary Bibliography.

This is an important book. While it is elementary, it contains an elegant introduction to the subject of mechanical vibration that will appeal most to those who can appreciate accurate, lucid and entertaining English—and those who can afford the rather high price.

Introduction to Nuclear Engineering. By RICHARD STEPHENSON, Ph.D. McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, London, E.C.4. Price 74s.

IT is a pity that British nuclear engineers are all too busy in practice to write text-books. To-day's best technical books for English-language readers are only too often American, not least the books on nuclear subjects. Here is an introductory text that has proved good enough to go into a second edition, and it saddens us to observe that nothing quite like it has come from an indigenous pen. We do not say this because we are insular. Knowledge is universal, and we deplore the artificial frontiers that national leaders strive to rule across scientific territories. Indeed, it is because of this opposition to the narrowly national approach that we should like to see a full and fair presentation of every country's efforts. Not that the book under review is intentionally unfair ; it is just that, with the great diversity and size of American effort in the nuclear field, work outside the U.S.A. must seem of relatively slight importance to an American writer. In fact, the present author tries to be just and comprehensive, and he includes an amount of material on foreign reactors ; but he makes mistakes in doing so. Thus Table 3-11, entitled " Central-station Power Reactors," attributes an electrical output of only 25MW to the Calder Hall reactors, and Table 3-2, " Natural Uranium—Graphite Reactors," omits Calder altogether though it includes the Windscale plutonium-producing piles, and Harwell's " Gleep " and " Bepo."

Are these carping criticisms ? To some extent, possibly : but the errors of which we complain will undoubtedly irritate the British reader when he discovers them, however much he may profit from the universal parts of the book : and the errors will actually mislead readers elsewhere in the world. It is this last that we find serious, for we feel that British nuclear achievement is important enough to deserve accurate reporting abroad. Text-books by authoritative British authors could do a great deal of good in this respect ; they could, for instance, help to correct the wrong impressions left when a writer like Dr. Stephenson says that interest in reactors of the Calder kind " is virtually zero " in the U.S.A.

This second edition improves and enlarges on the first. Two chapters have been added, one on the design of reactor cores, the other on thermonuclear power. The book opens, as it did in its first edition, with a skeletal account of nuclear physics, designed for readers familiar with the fundamental principles of the subject. Having passed lightly from quantum theory and the equivalence of mass and energy, through discussion of such matters as atomic structure and radioactivity, on to nuclear reactions and cross-sections, the author devotes a chapter to fission. This leads naturally to the fission reactor in its various forms, and these are described before presenting the theory in any detail. Neutronic diffusion theory is introduced via a review of the equations for the three-dimensional flow of heat. The one-

and two-group methods are described, with some allusion to multi-group calculations. Not altogether incongruously in this subject, the chapter on reactor theory ends with some notes on the experiments necessary to compensate for the imprecision of unsupported calculation. The troublesome subject of shielding is discussed, and reactor materials generally are considered, both as fully as the size (there are nearly 500 pages altogether) and scope of the volume permit. The newly-added chapter on core design is written mainly in terms of liquid cooling, but gas cooling does not go entirely unmentioned. Control and instrumentation share a chapter, and the special problems are introduced. The present reviewer, perhaps too much of a purist, would be happier if a para-differential symbol were not used to denote the quantity *reactivity*, but the intelligent student should not be misled by this rather unhappy notation. An account of the separation of stable isotopes is given briefly, but adequately enough for the purpose. Chapters 9 and 10 of the first edition (on chemical processes and special techniques) have been rewritten and telescoped into one. The new chapter on thermo-nuclear power is an interesting introductory survey, devoted mostly to the principles and referring little to current experimental work. After the latest Geneva conference the chapter dates a little, but it is impossible for text-books to keep fully abreast of work like this.

The volume is well presented on the whole, though some of the diagrams have been so much reduced for reproduction that they are difficult to make out (e.g. Fig 3–10), while others, of slight content, have been given excessively lavish space (e.g. Fig. 10–11). It is disappointing in a second edition to find such mis-spellings as "magawatts." A list of nomenclature and abbreviations, and an appendix providing data, are good features, but the index could usefully be enlarged. The book can be recommended to students seeking a first and general introduction to the subject.

The Industrial Challenge of Nuclear Energy : II, Research, Uses, Social Problems. European Productivity Agency, Organisation for European Economic Co-operation, 2, rue André-Pascal, Paris, 16e, France. Price 20s.

THE second "information" conference on nuclear energy, designed for the instruction of "management," was held in Amsterdam from June 24 to 28, 1957 ; the first conference had taken place in Paris two months earlier. The volume under review contains the papers that were read at the second conference, and is issued in an edition uniform with that published for the first conference.* The book deals with nuclear research, mineral resources, fuel production and processing, nuclear power for stationary and propulsive use, and social problems.

This continuing volume appears to have been more carefully produced than the opening one. The profusion of printers' errors that spoilt the report of the first conference has been avoided. However, as always where a multi-lingual occasion has to be recorded, there are lapses and obfuscations that make the going more difficult, though one is not always sure in such cases whether the obscurities should be laid at the door of the author or of the translator.*

One feels that there ought to be a technical editor, well versed both in the subject and the language of publication, to go through all such books as this before they are released. The burden on the translators' shoulders would then be eased, to the benefit of readers and authors together. A statement like that on page 48 of the present volume, to the effect that 22×10^{24}eV make 1kW, would not then go uncorrected, and "cynetic" energy (page 54) would be rendered into English. Absurdities such as the attribution of god-like creative powers to men ("the discovery of fission by nuclear physicists made atomic energy a reality," page 45), and the apparent merging of modern nuclear physics with ancient agriculture ("Waste absorption for reactor barns" is the title of a diagram on page 114) would be avoided. A competent editor would also correct the written record where perhaps a Homer has nodded in his speech. Thus, the opening address, in which conferees were apparently told that "already in the period 1939–1940 the possibilities of a practical application of nuclear fission were realised," might have been amended in the light of the historical fact that Meitner and Frisch first published their interpretation of Hahn and Strassman's results in a letter to *Nature*, dated January 16, 1939. Before then, "fission" was solely a biological phenomenon. Jargon, confusing to the laymen for whom this publication is intended, might have been pruned or explained by a good editor, so that substances identified as "U-20 w/o Pu-10·8 w/o Fs," or units like "TWh," might have been more easily recognised.

There is an alphabetic index of authors, but not of subjects. Bound in paper covers, this book has almost exactly the same number of pages as its predecessor, but it costs only two-thirds as much.

* See review in the THE ENGINEER, September 6, 1957, page 347.

Influence Lines for Continuous Beams. By W. C. BOYER and J. I. ABRAMS. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 80s.

IN this book are to be found tables giving the influence line co-ordinates for up to four span continuous beams of constant moment of inertia together with their reactions. Areas under the curve are also given, thus facilitating the determination of the bending moments caused by uniform loading. The cases of non-uniform moments of inertia are not dealt with. The tables are augmented by graphs plotted in dimensionless form giving reactions, support moments, &c.

The tables, which were originally produced in three reports, were prepared for the States Road Commission of Maryland by the Johns Hopkins University. It is not clear what significant advantage these tables have over Angers' "Ten Division Influence Lines for Continuous Beams," recently reviewed in these columns, except perhaps for the clarity of the print and for the additional significant figure. It strikes one with dismay that these tables have been computed "to serve the genuine need of the design engineer" when such tables were already in existence. How much other work is now being duplicated ?

Water Power Engineering. By ROLT HAMMOND, A.C.G.I., A.M.I.C.E. Heywood and Co., Ltd., Ingersoll House, 9, Kingsway, London, W.C.2. Price 50s.

IT is characteristic of Mr. Rolt Hammond's books that he does not give a textbook exposition of the underlying theory of his chosen subject, but rather attempts to review current practice and trends in development. *Water Power Engineering* is conceived along these lines, and its text embodies numerous examples of what has been done in the last few years to improve performance and generally extend the scope of generating electrical power from water. It has been estimated that power requirements in most countries tend to double over a period of about ten years. Thus, in countries where water power resources are available, the tendency is for the rate of new hydro-electric construction to increase in geometric progression, following the growth of electrical load. It is thus becoming increasingly difficult for a student of the subject to keep pace with all the new developments, and any review, such as this one, which draws generously upon the actual achievements of the past few years will find many interested readers.

The subject matter is presented in the following chapters :—"The Water Power Industry" (a general review of the whole subject) ; "Water Turbine Design" (emphasising recent achievements); "Electrical Problems" (again a rather general review) ; "Hydro-Electric Developments" (examples of schemes of special interest throughout the world, including pumped storage schemes) ; and "Tidal Power" (a historical introduction, and notes on the Rance scheme in France).

Books of Reference

Manual of Civil Engineering Plant and Equipment. Compiled by J. M. Paxton. Contractors Record, Ltd., Lennox House, Norfolk Street, London, W.C.2. Price 130s.—This ambitious work of reference has as its aim the presentation of specifications of civil engineering plant and equipment in sufficient detail to enable a prospective purchaser to compare and select plant for any given task. The specifications are classified by firms (in alphabetical order), and the products of 240 firms are thus listed ; each of these firms is a manufacturer or sole concessionnaire. The scope of the book is limited to plant and equipment, for civil engineering, which is essentially mechanical in character. Over 5000 items of plant are listed. In the case of a large or complex item of plant, the descriptive matter about it may extend to 1000 words or more, but most of the plant is not illustrated, there being about 1000 line drawings in the book. The index gives cross references of all firms listed which supply any particular class of product. With increasing mechanisation in all building and civil engineering operations and, consequently, increased diversity of the plant available, a directory of this kind has obvious value. With 240 firms contributing it would appear to be pretty comprehensive, and apparently the intention is to keep it up to date.

Merchant Ships : World Built, 1958. Adlard Coles, Ltd., 7, Brunswick Place, Southampton. Price 35s.—The book opens with an introduction by A. C. Hardy and contains particulars of 850 ships of over 1000 tons gross delivered in 1957, while in Part II are some seventy ships representative of those under 1000 tons. In Section I is a general review of shipbuilding in 1957 and in the next section is a list of owners and their new ships, followed by some seventeen sections each devoted to the shipbuilding activities of individual countries. That part of the book dealing with small ships is divided into four sections, which deal with coasters, trawlers, miscellaneous ships and tugs by means of photographs and drawings. Finally, there is an alphabetical list of merchant ships of 1000 tons gross and upwards completed during 1957.

Books Received

Progress in Cargo Handling. Vol. 2. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 63s.

Automation in Production Engineering. By J. A. Oates. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 45s.

Automation, What It Is, How It Works, Who Can Use It. By Carl Dreher. Victor Gollancz, Ltd., 14, Henrietta Street, London, W.C.2. Price 12s. 6d.

Radiation Hazards and Protection. By D. E. Barnes and D. Taylor. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 30s.

Sir William Halcrow

THE death occurred last Friday of Sir William Halcrow ; he was 75. Sir William's career was indeed a fine example of that grand manner in civil engineering which the profession has inherited from the early days of industrial expansion, and which nowadays tends to be obscured by the growth of specialised technologies. His practice was world wide, and the works he designed were varied in kind and included docks and harbours, tunnels, hydro-electric schemes, road and rail schemes, and power stations. Apart from directing civil engineering projects of great size, he served on many committees and advisory bodies, and was a member, during the war, of the war cabinet's engineering advisory committee. His early years saw service with both consultant and contractor, before he joined the firm which now bears his name, and from partnership of which he retired three years ago.

William Thomson Halcrow was educated at George Watson's College and Edinburgh University. He was a pupil with Patrick Walter Meik, M.I.C.E., then senior partner in the firms of Thomas Meik and Sons and P. W. and C. S. Meik. His early experience included engagement as an assistant on the construction of the Kinlochleven hydro-electric works and resident engineer on the reconstruction of a pier at Pozzuoli, Italy. In 1910 he accepted an appointment with a leading firm of Westminster civil engineering contractors, Topham, Jones and Railton, Ltd., and was engaged on the construction of the King George V dry dock in Singapore.

In the year the first world war broke out he was in charge of the construction of the defences of the Invergordon naval base and for his work received the thanks of the Lords Commissioners of the Admiralty. During the war he was in charge of the submarine and land defences at Scapa Flow, and then returned to Singapore to take charge of the construction of the Johore causeway.

On returning to London, he was taken into partnership by the late C. S. Meik in 1922. His partner died in 1923, and in 1924 he was entrusted with the Lochaber water power works for the British Aluminium Company, Ltd., which has the largest output of power of all the hydro-electric schemes in Scotland, and includes the 15-mile Ben Nevis tunnel.

Sir William Halcrow and Partners, as the firm is now known, has since been connected with many of the developments—or of those proposals during the 1930s which were frustrated—of Highland water power, and in particular with the Affric, Garry and Moriston schemes. It is worth reflecting here how much this subsequent activity owed to the sound design and execution of the Lochaber scheme. The work at Lochaber was unusually original in several of its aspects, and was succinctly described by Halcrow in a paper presented to the Institution of Civil Engineers in November 1930. The success of this scheme was doubtless of great value to the progress of British hydro-electric engineering during the difficult decade before the war. It is interesting to recall figures of cost per horsepower quoted in the discussion on this paper ; at Niagara, a power station had been built at that time for £27 per horsepower, whereas for the smaller scheme at Lochaber the cost had been kept as low as £37 per horsepower, which, it was considered, spoke very well for the latter considering the difficulties.

Other hydro-electric works with which Sir William was concerned included schemes in Ireland, Jamaica, Venezuela, and British Honduras, and investigation into the Kariba and Kafue schemes (he was a member of the panel appointed to report on these schemes) and the Volta river project with all its associated developments which altogether will cost £60,000,000 to build, it is estimated. He was also chairman of the panel which reported on a related project, the Severn barrage proposal.

Two other aspects of Sir William's civil engineering work should be dwelt on, as well as his contribution to hydro-electric engineering. They relate respectively to tunnelling and to harbour and dock construction. His firm has been responsible for 66 miles of deep tunnelling in the large cities of this country, and more recently, for the deep tunnel from Hampton to Chingford which the Metropolitan Water Board is constructing. Other noteworthy work in this field included deep-level shelters, tunnels for the Admiralty, and the Woodhead railway tunnel. Amongst major harbour works which Sir William has directed are those at Beira, Tema and Tripoli in Africa.

Throughout all this activity, the firm which, in 1922, he entered as a partner, gradually attained to its present eminence, in the front rank and amongst the largest of British consulting engineering organisations. The scale and variety of works now under its care is as varied and as world-wide as its principal partner would have wished.

During the second world war, Sir William's advice and experience were clearly put to important use. His position on the war cabinet's engineering advisory committee has already been mentioned. He was also consultant to the Secretary of State for War on ports, including the Mulberry Harbour, and was responsible for design and supervision of construction of the "Phoenix" units for this project. He was also adviser to Bomber Command, and was responsible for protecting the Underground tunnels from flooding from the Thames through enemy action, and for deep level tunnel shelters in London. Another wartime task of great responsibility was his position as head of a group of consulting engineers who were responsible for the design and construction of ordnance factories for the Ministry of Supply, and storage depots for the War Office, the total value of all this work being about £10,000,000.

Sir William became president of the Institution of Civil Engineers in the session 1946–47. His address did not follow the traditional pattern of reviewing the engineering works of which he had had experience, although it will be clear from those amongst Sir William's professional achievements which we have mentioned, that an address along those lines would have been exceedingly good. Instead, he chose to comment on the work of the Institution, and the progress it was making, in directing the affairs of the profession, by its publications and its other activities.

Another aspect of his activities, which illustrates how the experience of a varied and long career can be of benefit to the community generally, was service on advisory committees, of which Sir William's chairmanship of the Hydraulics Research Board and the Froude Tank Committee may be noted. He was also a member of the Advisory Committee of the D.S.I.R., and sat as a member of various of the D.S.I.R.'s research boards, and was a member of the Air Safety Board. He actively promoted the affairs of international bodies such as the World Power Conference and the Permanent International Association of Navigation Congresses, by his membership and service on committees.

Perusal of Sir William's writings will reveal a style of unusual directness and polish. His interests were not limited to matters of engineering, a fact which was reflected in his appointment as a member of the Royal Fine Art Commission, which is a rather unusual office for a civil engineer. Not all, by any means, of the major civil engineering projects with which he was associated have been mentioned in this appreciation of his career, nor have all the bodies to which he belonged been listed, for the list is very long. But perhaps we have said enough to show that his career was unusually brilliant and energetic, and his death is a sad loss to the civil engineering profession.

Nuclear Power for the Propulsion of Commercial Shipping*

By SIR JOHN COCKCROFT, O.M., F.R.S.

The lecture reviews the present state of development of nuclear propulsion for shipping in the light of the technical performance of the U.S. nuclear submarines and the information disclosed at the Geneva Conference on the development of commercial nuclear propulsion. Five types of nuclear reactor for propulsion purposes have so far been considered: the pressurised-water reactor, the boiling-water reactor, the sodium-cooled reactor, the gas-cooled graphite-moderated reactor and the organic-liquid-moderated reactor. On present information the boiling-water reactor seems likely to have lower capital costs than the pressurised-water reactor, and with substantial development they might approach those of conventional propulsion systems. Fuel costs for nuclear propulsion systems depend on the cost of enriched fuel and on the cost of fabrication of fuel elements, and to achieve costs equal to oil-fuel costs would require the use of low cost enrichment.

IT is appropriate that in this Andrew Laing lecture I should discuss the possibilities of commercial nuclear propulsion, even though at present any changes to nuclear propulsion for merchant shipping seem remote.

The technical feasibility of the nuclear propulsion of ships has been demonstrated by the performance of the U.S. submarines "Nautilus" and "Skate." The "Nautilus" has steamed over 100,000 miles, 70 per cent of the time submerged. In her recent voyage under the polar ice cap she travelled 1800 miles submerged and travelled 2900 miles from Pearl Harbour at an average speed of 20 knots, 90 per cent of the time submerged. The "Skate," a smaller submarine, has already steamed over 12,000 miles, 10,000 of these submerged, and crossed the Atlantic to Portland submerged in seven days, five hours. With normal use a single charge of fuel will last well over a year, so that the time at sea is limited by the endurance of the crew.

Commercial Nuclear Propulsion

Although the technical feasibility and reliability of nuclear propulsion can be taken for granted, the economic feasibility of commercial nuclear propulsion is less certain. The "Nautilus" is powered by a nuclear propulsion unit developing about 20,000 s.h.p. The heat is developed by a pressurised-water reactor producing steam for turbines. The cost of the propulsion system has been said to be about 30,000,000 dollars, as compared with 4,000,000 dollars for a commercial oil-propulsion unit. Admiral Rickover has stated that the fuel costs for the first charge of fuel were about ten times commercial fuel costs.

The cost of operation of a commercial ship has three components, and these are given in Table I for a 47,000-ton conventional tanker carrying oil between the Persian Gulf and the U.K.

Table I

Capital charges on hull and engines, 15 per cent on £3,000,000	£450,000 per annum
Fuel costs	£200,000 per annum
Operating costs	£150,000 per annum
	£800,000

This shows that with normal commercial financing, if the capital cost of a nuclear ship was £1,000,000 more than a conventional ship, leading to an additional capital charge of £150,000 per annum, nuclear fuel costs would have to be as low as £50,000 per annum, or a quarter of conventional fuel costs, for the nuclear ship to break even.[1]

Capital costs per shaft horsepower fall more rapidly with increasing power for nuclear units than for conventional units. Nuclear propulsion will therefore be more competitive for high power than for small units. Since capital costs will be high, operation on a high load factor will be the most likely objective for nuclear propulsion. Table II gives typical power requirements and load factors for different classes of ships.

Table II

	Total power s.h.p.	Load factor, including hotel load
		Per cent
"Queen Elizabeth"	160,000	60
"Canberra" (P. and O.)	85,000	55
"Oriana" (Orient)	80,000	55
100,000-ton tanker	40,000	80
North Atlantic liner ("Saxonia," 22,000 tons)	23,000	50
47,000-ton tanker	16,000	80
Cargo liner (15,000 tons)	7,500	45

From these figures, tankers above 40,000 tons deadweight requiring 16,000 s.h.p. upwards are candidates for nuclear propulsion. However, a 16,000 s.h.p. unit is still a small-scale unit in the nuclear field.

The Pressurised-Water Reactor Propulsion Units

For some time to come it seems likely that nuclear propulsion units will use steam turbines and the nuclear reactor will simply supply heat to raise the necessary steam. The pressurised-water reactor of the "Nautilus" type is being used for all save one of the U.S. naval vessels and will also be used for the U.S. "Savannah"—a combined passenger-cargo ship—and the Russian ice-breaker. The "Savannah" will, however, use nuclear fuel of much lower enrichment than the "Nautilus" fuel.

I will therefore draw on published information about the "Savannah" to illustrate the properties of this type of reactor.[2,3] The "Savannah" will be a single-screw vessel, 595ft long by 78ft beam. It will have a full load displacement of 22,000 tons and will carry sixty passengers and a cargo of 9400 tons at a normal speed of 21 knots. Details of the propulsion unit are given in Table III.

Table III

Shaft power, s.h.p.	22,000
Shaft speed, r.p.m.	110
Turbine inlet pressure (dry, saturated steam), p.s.i.a.	460
Main condenser pressure, inches hg abs.	1·5
Feed water temperature, deg. Fah.	343
Steam generation:	
For main turbines, lb/hr.	204,625
For other uses, lb/hr.	55,325
Total	259,950
Total electrical load, kW	1,850
Reactor heat generation, MW	68
Reactor pressure, p.s.i.a.	1,750
Reactor flow, lb/hr.	8,000,000
Primary water temperature rise through reactor, deg. Fah.	24·6
Primary water mean temperature, deg. Fah.	508
Boiler temperature (dry and saturated), deg. Fah.	464

The heat is developed in fuel elements which consist of sintered uranium oxide, containing about 4 per cent of U^{235}, clad in 0·026in stainless steel. Uranium oxide is chosen because it withstands irradiation damage well and is also very resistant to corrosion by hot water. The stainless steel normally prevents any contact of the UO_2 with the hot water. It is important to prevent radioactive fission products appearing in the heat-exchanger and circulating pumps.

A view of the reactor core is given in Fig. 1. The core is contained in a pressure vessel and

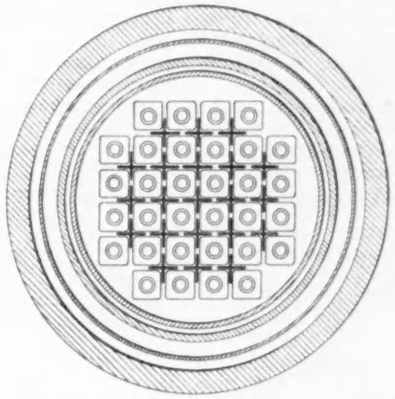


Fig. 1 of Preprint 96, by P. M. Wood and Z. Levine—Babcock and Wilcox Company. Nuclear Engineering and Science Conference, March, 1958, Chicago.

Fig. 1—Top view of merchant ship reactor for N.S. "Savannah"

is 61in across and 66in high, and contains thirty-two fuel elements about 9in square and about 92in total length. The fuel elements are kept in place by an "egg crate" type of lattice. Between the fuel elements are twenty-one cruciform-shaped control rods with top mounted drive.

The most difficult problem of the PWR reactor is to ensure that the chain reaction can proceed, developing the full amount of heat throughout the lifetime of the core and that there will never be in the life of the core "a hot spot" where the coolant stream would be insufficient.

The designer decided that the reactor core of the "Savannah" should be able to produce 68MW of heat for the equivalent of 600 days. This long life of the core was chosen because changing the core takes a long time with the existing PWR design. In each day about 80 grammes of U^{235} would be fissioned, so that a total burn-up of 48 kg has to be provided for.

The nuclear design is best illustrated by a neutron balance sheet as given in Table IV.

Table IV—*Neutron Balance Sheet*

	Gains	Losses
Neutrons liberated from 1 fission in U^{235}	2·46	—
Neutrons from fast fission of U^{238}	0·12	—
Neutrons required to produce the next fission	—	1·00
Neutrons leaking	—	0·27
Neutrons captured in U^{238}	—	0·50
Neutrons captured in stainless steel	—	0·30
Neutrons captured in moderator	—	0·11
Neutrons captured in U^{238} but which do not cause fission	—	0·22
Additional neutrons absorbed by increasing temperature	—	0·06
Neutrons absorbed by xenon and samarium	—	0·03
Neutrons absorbed by burnable boron "poison"	—	0·03
Neutrons to provide for reactivity run-down during core life	—	0·04
Contingencies	—	0·02
	2·58	2·58

The first two lines show the neutrons liberated by one fission in U^{235} with the bonus obtained by the fissions produced in U^{238} by the outgoing fast neutrons. Of the initial neutrons a high proportion leak out of

* The Twenty-Seventh Andrew Laing Lecture, North East Coast Institution of Engineers and Shipbuilders, October 31, 1958. Abstract.

the core without producing a further fission and a high proportion are captured in U^{238} to produce plutonium. The use of thick stainless steel cans for the fuel elements results in a substantial wasteful absorption of neutrons. Some neutrons are necessarily captured in the water moderator. We see then that 2·4 neutrons are absorbed in the initial cold state of the reactor, so that there is a handsome surplus—16 per cent of reactivity.

This 16 per cent is, however, required to provide for extra absorption as the reactor goes on power. With increasing temperature the moderator expands and gets less dense, and more neutrons escape. The fission of uranium produces fission products which absorb neutrons. The most important of these are samarium and xenon. The burn-up of the 48 kilos of U^{235} results in a greater absorption of neutrons in the U^{238} which steadily reduces reactivity (Fig. 2). To reduce the effect of this long-term decrease

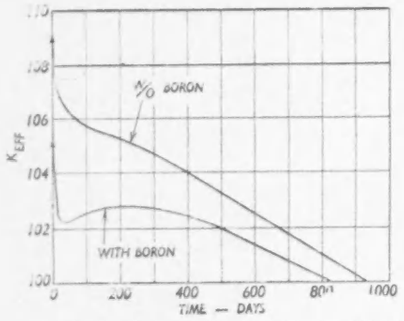


Fig. 4 of Preprint 96. By P. M. Wood and Z. Levine—Babcock and Wilcox Company. Nuclear Engineering and Science Conference, March, 1958, Chicago.

Fig. 2—Reactivity versus operating time at 74MW with burnable poison (B^{10}) non-uniform radial burnout for N.S. "Savannah"

of reactivity, boron is introduced as a "burnable poison." The boron absorbs neutrons strongly, but since it is steadily destroyed by neutron capture its absorption becomes less, and this counteracts the increased absorption due to U^{235} burn-up.

The main lesson to be drawn from this illustrative neutron balance sheet is that to improve neutron economy and so reduce fuel costs, the main variable at the designers' disposal is the proportion of neutrons absorbed in the stainless steel fuel-element sheaths. If this can be reduced by using thinner stainless steel or by substituting a material such as Zircalloy which absorbs fewer neutrons, then the extra neutrons made available can be invested in increased neutron absorption in U^{238}—by decreasing the fuel enrichment, so increasing the proportion of U^{238} in the fuel. This will result in more plutonium being produced. This means that we can use a lower initial investment of fuel.

The accumulation of radio-xenon has an important short-term effect on operations. Xenon 135 is formed from a primary fission product Iodine 135, as shown.

$$I^{135} \xrightarrow[(6{\cdot}7h)]{} Xe^{135} \xrightarrow[(9{\cdot}2h)]{} \begin{cases} Xe^{136} \text{ by neutron capture} \\ Cs^{135} \text{ by decay} \end{cases}$$

During operation the Xenon 135 is destroyed by neutron capture and also decays to Cs^{135}. It therefore builds up to an equilibrium concentration. However, when the reactor is shut down, the destruction by neutron capture stops, but the build-up from I^{135} goes on, so the absorption increases. Unless there is sufficient spare reactivity designed into the core it might not be possible to start up again until part of the radio-xenon had decayed to Cs^{135}. So spare neutrons have to be provided for this.

Another interesting feature of the pressurised-water reactor core is its response to load changes. The reactor has a high degree of self-regulation. An increase in power demand leads to a drop in the temperature of the returning water and a contraction in volume. This increases reactivity because the neutron escape and absorption is less. As a result, large speed changes can be made without moving the control rods.

The shield has to be designed to absorb most of the neutrons escaping from the core so that the intensity of radiation in the external reactor compartment is small and after a few hours of shut-down the crew can enter. The primary shield of the "Savannah" is an annular steel tank of water 33in thick with an outer layer of 2in to 3in of carbon steel. This reduces the dose rate in the steam generating compartment to a figure of 1 röntgen per hour shortly after shut-down. Thereafter the radioactivity decays rapidly so that, by waiting a few hours, maintenance operation would be possible.

The whole reactor/steam generating system is contained in a steel containment vessel 35ft in diameter and 50ft long (Fig. 3). The containment system is designed to withstand

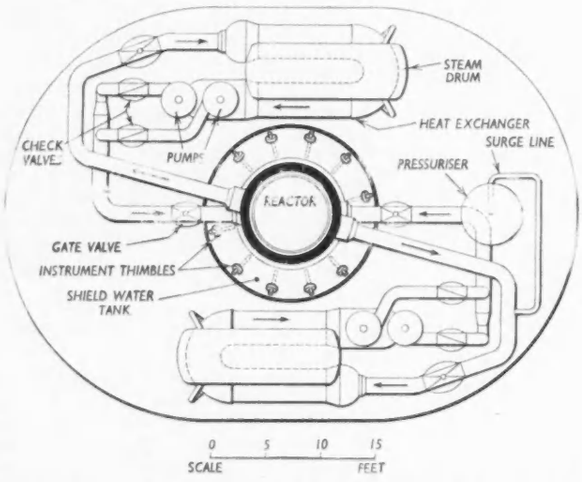


Fig. 4 of Preprint 69, "Design of the Power Plant for the First Nuclear Merchant Ship," by R. L. Whitelaw, Nuclear Engineering and Science Conference, March, 1958, Chicago.

Fig. 3—Reactor system arrangement in containment in N.S. "Savannah"

the pressure of 186 lb per square inch which would develop due to flashing steam, if the entire primary and secondary system were to rupture. The containment vessel is shielded above its equator with 30in of barytes concrete and below the equator with 48in of ordinary concrete. Outside this shielding the dose rate is not more than 5 röntgen a year—the maximum permissible annual dose to an operator.

Economics—Full details of the operating costs of the "Savannah" have not been published. Nevertheless, it is useful to make a rough estimate of these costs.

In the U.S., enriched uranium fuel can be hired from the U.S.A.E.C. at an interest rate of 4 per cent, and a table of prices for fuel of varying enrichment has been published. The operator has to pay 4 per cent on the fuel investment and also to pay for the U^{235} burnt in the course of the fuel life. The spent fuel elements will be sent back for chemical processing and refabrication. In the chemical plant the fission products and plutonium are extracted, and the uranium enrichment is then made up to the original value. The uranium has then to be reconverted into oxide for the fuel elements and clad again in stainless steel. The operator will be credited with the value of the plutonium in the spent fuel.

Fabrication costs and recycling costs have been estimated by scaling published data for the Yankee Atomic Electrical Power Station (YAEC-1).

On this basis very approximate estimates of the fuel costs are given in Table V.

TABLE V—*U.S. Operated Marine Pressurised-Water Reactor Fuel Costs*

	Pence/s.h.p./hour
Burn-up of U-235	0·237
Interest on fuel inventory at 4 per cent per annum	0·088
Fabrication	0·187
Chemical processing	0·120
	0·63
Less credit for Pu formed, at 12 dollars per gramme	0·06
Total	0·57

Capital costs of the "Savannah" reactor and propulsion machinery have been given as follows[4]:

Reactor and power plans, 14,500,000 dollars.

Shielding and containment, 1,500,000 dollars.

This is about 10,000,000 dollars above the cost of a normal propulsion unit of the same power built in the U.S.A.

On this basis the comparative annual costs for operating conventional and nuclear tankers with a propulsion unit of the "Savannah" type in the early 1960s are given in Table VI.

The total annual cost of a nuclear unit would therefore be about 80 per cent higher than commercial costs. The important question is how far capital costs and fuel costs can be reduced. Unless oil prices rise very significantly, nuclear propulsion can only compete if the capital cost of the nuclear vessel is reduced to little more than that of a conventional vessel.

THE BOILING-WATER REACTOR

An alternative reactor system which seems likely to achieve lower capital costs is the boiling-water reactor. Steam is generated in the core and passes direct to the turbine, thus eliminating the heat exchanger. The system pressure is also lower—about 600 lb per square inch—as compared with 1500 lb per square inch for the pressurised-water reactor. This saves cost and weight. There are still some questions about boiling-water reactors that we cannot answer with certainty. First, it is not likely that a direct coupled turbine and condenser will become unacceptably

TABLE VI

	Nuclear	Oil fuel
	£	£
Capital charges on hull and engine	986,000	450,000
Fuel	330,000	200,000
Operating costs	150,000	150,000
	1,466,000	800,000

active if the fuel elements remain intact, but we do not yet know whether the activity can be held at this low level if some of the fuel elements develop defects. If the activity level rises the turbine would have to be shielded. Second, boiling-water reactors can become unstable if we try to take too much power from their cores and it is not yet possible to assess what is the critical power level. However, American experience suggests that it is not a problem with the size of reactor that is required for propelling a ship. Third, the control of a boiling-water reactor may be more complex since it does not necessarily have the same sort of self stability as the pressurised-water reactor.

The U.S. have discussed the installation of a boiling-water reactor coupled to a 22,000 s.h.p. propulsion unit for a 38,000 deadweight tanker. The fuel elements would consist of a mixture of uranium oxide and thorium oxide clad in Zircalloy, so fuel costs ought to be appreciably less. The capital costs of the ship are estimated to be 45 per cent higher than conventional costs. The overall operating costs are estimated to be 24 per cent higher than a conventional tanker using oil at 2·60 dollars a barrel.

The United Kingdom Commercial Nuclear Propulsion Programme

In Britain, the A.E.A. in collaboration with the Admiralty and the B.S.R.A. are studying the type of nuclear propulsion unit which would be most economic for propulsion of a large tanker. The possible application of the advanced gas-cooled, graphite-moderated reactor to this purpose has been recently discussed.[5] The conclusions were that fuel costs would be as low as 0·2d./s.h.p. hour but that capital costs of the propulsion system would be from 50 to 100 per cent higher than conventional propulsion units. Combining these two components they considered that the nuclear tanker would break even with the oil-fuelled tanker for a displacement of 70,000 tons. A land based A.G.R. nuclear power unit to develop 28MW of electricity is now being built to test the technology.

An alternative system of interest to the United Kingdom would seem to be the boiling-water reactor. Reasonable fuel costs could only be achieved by using by-product plutonium from the future Electricity Board reactors to provide the necessary enrichment.

Nuclear Propulsion in the U.S.S.R.

At the Geneva Conference, the U.S.S.R. reported on the design of the nuclear-propelled icebreaker "Lenin" which is to come into commission next year. The icebreaker displacement is 16,000 tons powered by turbines of 44,000 s.h.p. There are three pressurised-water reactors, one of which is a stand-by. Each reactor has an independent primary circuit in which high-pressure coolant is circulated. In a second circuit water of reduced pressure is heated and transformed into superheated steam.

The icebreaker is capable of moving through 2m thick ice floes with a speed of 2 knots. In ice-free water it has a speed of 16 knots.

The Safety of Nuclear Propulsion

There is nothing to fear from radiation hazards in the course of normal operations in a nuclear ship, provided that well-established rules for design and operation are followed. Two main classes of abnormal hazards have to be considered. The first is collision damage, bearing in mind that this is more likely in port, narrow waters or harbour approaches. Nevertheless it should be remembered that the number of collisions of large ocean-going ships in populated areas is very low. According to accident returns, with 100 nuclear ocean-going ships there would only be one potentially dangerous accident in British waters in the vicinity of a populated region every thirty years. Protection against collision is provided in the "Savannah" by its containment vessel and by the secondary shield, which includes alternate layers of redwood and steel.

The authors of a Geneva paper[6] recall that the perpendicular impact of the ship "Stockholm" at 20 knots against the "Andrea Dorea" resulted in penetration of 15ft into her hull and considered it unlikely that the "Savannah" containment system could be penetrated. The U.S. coastguard consider that an object 0·2 ship breadths from the side is safe from direct collision. The "Savannah" containment vessel is 0·275 ship breadths inboard.

If the ship is sunk by collision the containment vessel should therefore remain intact. In shallow water it will remain so and would dissipate residual nuclear heating by convection. In deeper water bursting discs would flood the containment vessel before rupture. Any corrosion of oxide fuel elements by penetration by sea water would be very slow.

The most important hazard would seem to be due to a rupture of the primary cooling circuit and subsequent flashing of water to steam, followed by melting of the fuel elements and release of the fission products. The course of this "maximum credible accident" is analysed by Godwin and Dorf who conclude that even in such extremely incredible circumstances the containment vessel would contain the molten fuel and largely prevent escape of radioactive products.

A less extreme hazard would be provided by the failure of the circulating pumps and simultaneous failure of the control rods to shut down the reactor. This again would lead to melting of the fuel unless an emergency shut-down system were provided. The analysis of these "just conceivable accidents" guides the designer in designing against the worst possible combination.

Bibliography

[1] S. L. Smith and J. E. Richards, Geneva Conference paper No. P/265.
[2] R. L. Whitelaw, Nuclear Engineering and Science Conference, Chicago, March, 1958.
[3] P. M. Wood and Z. Levine, Nuclear Engineering and Science Conference, Chicago, March, 1958.
[4] Zinn, Geneva paper P/1831, 1958.
[5] Iliffe and Moore (Geneva Conference paper P/266).
[6] Godwin and Dorf, P/1023.

Production Control by Computer

A short report was given in our issue of October 31 of a one-day conference on the appraisal of computers which was organised by the British Institute of Management. In that report a brief mention was made of the work carried out in a Letchworth factory of the British Tabulating Company, Ltd., in applying a Hollerith electronic computer to a production control system. The factory selected for the investigations and introduction of a computer control system is relatively small, with about 500 employees, engaged in manufacturing a sub-assembly for an adjoining works of the company. It is typical of many factories in that it uses bought-out components and raw materials and incorporates a machine shop, with a varied range of typical machines, and produces unit sub-assemblies for a final assembly section.

In the course of a recent visit to the works of British Tabulating Machine Company, Ltd., at Letchworth, we saw one of the company's small factories in which there has been introduced a production control system using the Hollerith electronic computer. This system was developed following detailed studies of production carried out over a period of about two years, and although it has only been in use for about three months, it is considered to promise such effective results that plans are in hand for the introduction of the system on a long-term basis to other of the company's factories. The system has shown that the computer can be used as an effective tool for management in providing a rapid and practical means of integrating stock control with production, and in relating production to demand without involving a large volume of paper work. The ability of the system to provide at short notice either advance or retrospective analyses of production quickly shows up weak spots in organisation, whilst enabling speedy replanning of production when necessary. It further promotes economies in that, by interrelating supplies of materials and the manufacture of parts or assemblies, expensive buffer stocks do not have to be maintained. With the basic information which is available of the capacity and facilities for every facet of production a manufacturing programme can be prepared quickly and without need for the large number of calculations entailed in the usual methods of planning a detailed production programme.

An interesting detailed report on this initial system has been prepared by the British Tabulating Machine Company, Ltd., and from it we have abstracted an outline of the work involved. The factory in which the system has been introduced employs about 500 people and is divided into the following shops and departments:

Machine shop—with a range of autos, capstans, drills, presses, and one or two special purpose machines; assembly shop—with sections for coil winding, relay assembly, cable harness, control panel assembly, brush assembly; special order department—with grinders, lathes and jig borer; inspection and stores.

Programme Breakdown

For the introduction of the system there was prepared an agreed consolidated programme setting out the requirements, for a twelve months' period starting from a specified date, of specified end products—complete machines, assemblies or piece-parts. Of these requirements, those for the first four months were treated as positive and firm, those for the subsequent eight months as tentative and subject to revision. The overall programme is to be reviewed and revised thrice yearly and upon each revision the positive requirement brought forward four months in time. A card was punched up for each end product in the programme, identifying the product and stating the number of units called for in each of a predetermined number of periods of time ahead. In this form information can be fed into the computer, stored in specific identifiable locations on the tracks of the magnetic drum and held there to serve as a multiplier in subsequent calculations.

The multipliers having been determined, it becomes necessary to find the multiplicands. Records available showed the unit content

of each type of end product, i.e. the number or quantity of each item required to make " one-off " of that end product. Each such component item is identified by a part number and the record shows the " number off " of the item in one unit of the end product. This record of the unit content of the individual end product is a constant.

This " constant " information was arranged in a suitable form and what are known as " Binary Part Master Cards " punched to form a permanent file of master cards which, subject to detail modification on a specification change, can be used and re-used as often as required for a new breakdown.

In this file of Binary Part Master Cards, the firm has a permanent record for each item, those end products in which it is used and the number in each end product. This information is fed into the computer to relate it to the information already stored there about the end product—the quantity required. By successively multiplying together the paired quantities—end product requirement quantity, by number off, of constituent item (by Part No.) per unit of end product and accumulating the results of the successive multiplications, the total requirement of each item (by Part No.) is obtained. In this way there is established the overall requirement of items to enable the making of end products to the consolidated " Programme of Requirements."

Having accumulated the results of successive multiplications to get the total (gross) requirement of each item one then subtracts from such total the free stocks of the item available, so obtaining for every such item a net requirement. This is the number which serves as the basis for initiating procurement action—either by purchase department or production, according to the location indication on the Binary Part Master Card. The establishment of these net requirements is, of course, the reason for carrying out the " Programme Breakdown."

The method outlined, which gives a " one-shot " breakdown by directly relating the constituent item to the quantity of end products for which it is required, demonstrates how rethinking a problem, in order to put it on the computer, can contribute to more effective results. A programme breakdown for the whole manufacturing unit—which would by other methods take several weeks—can be carried out in a matter of days.

Plant Loading

The firm points out that plant loading is a complex, difficult and highly controversial subject, not easy to describe in detail. It will be remembered that one of the end products of the programme breakdown procedure was a statement of requirements of made-in items. This statement was taken from the gang punch unit of the computer in the form of a file of punched cards, and this file of " Requirement Cards " forms the starting point for plant loading procedure, since it provides information as to what is to be made, how many are to be made, and where they are to be made. It is not yet known in what order the parts are to be made or when to start making them. Here it is pointed out there is met an apparent paradox of manufacture that in the factory no one is concerned with the items to be made—the parts, &c., as such. They are interested solely in the operations whereby any such item is made. Given that these operations are performed correctly, in their correct sequence, the inevitable result is—the part. It is therefore necessary to establish what the requirements—as defined during the programme breakdown and recorded in the file of requirements cards—represent in terms of operations. For this purpose use is made of a file of " Binary Operations Master Cards," which contains, for each operation, data as to the number of hours (to the nearest tenth of an hour) required to perform that operation upon some quantity of a particular item identified by part number. The " Binary Operation Master Card " used gives a correct sequence of operations defining, for each operation :

(*a*) The set-up time in hours to the nearest one-tenth.

(*b*) The allowed time for one off.

(*c*) The interval time allowed between a particular operation and the next in sequence. Provision for interval time is necessary in the scheme to allow for handling between machines and similar not-precisely-definable events. Delay occasioned by the exceeding of this allowed interval time can thus be spotlighted and investigated.

The sum of these three times for a particular operation is the overall operation time, from which it follows that the sum of all the overall operation times should be the time required to make an economic batch.

It is then determined when—in the overall production cycle—each part (or assembly) has to be made. Some items—especially fitting parts—may be called for several times, at different stages of assembly. In such circumstances the earliest date is the material one. Obviously on the date so determined a part must be in existence, which determines the finishing date for the making of a batch of such parts. With the agreed delivery date known, which may be ten weeks, there is established what parts and assemblies are required for final assembly of the end product and when they will be required. For simplicity let it be assumed that the final assembly takes one week. Then all items required for final assembly must be in existence nine weeks from the beginning of the production period. Suppose a piece-part A takes one week to make, piece-part B two weeks and assembly X four weeks then, for the particular end product, it will be necessary (at latest) to start manufacture of piece-part A in the eighth week ; piece-part B in the seventh week ; and assembly X in the fifth week. So it goes for each piece-part or assembly required at final assembly stage. This analysis is carried to its logical conclusion establishing on the computer—within the ten-week production cycle—the time at which any part or assembly must exist in order that it be available for use in the next production stage.

The requirements cards and binary operation master cards above described together provide the means of establishing a picture—in absolute time—of how the requirements should be met and when, in relation to some production cycle. This—of course—presupposes a hypothetical factory standing by completely equipped and freely available to cope with any demands. Such conditions, however, do not exist in a going concern making products for some previous programme. To take account of these conditions there is a third file of cards, in which is recorded the overall capacity—and the existing load—in terms of machine tool groups. The difference between overall capacity and existing load represents, in effect, the stock of time available on specific machine tool groups during particular weeks of the production cycle.

The three files of cards available, thus give :

(*a*) Net requirement of parts and assemblies—derived from previous computer exercise on programme breakdown.

(*b*) Operations in correct sequence to make each part or assembly.

(*c*) Capacity of the several machines and facilities by group—overall and available—each week.

The computer is used first to calculate overall load (existing load and new load) for each machine tool group during each production cycle. From this calculation one can deduce whether the added requirement will result in overload anywhere along the line and if so, where, and decisions can be made as to how to deal with it. Having established the broad picture, detailed plant loading is effected at more frequent and proximate intervals. Starting at any given week of the production cycle—such starting point being defined by the latest completion date for a particular part—and taking advantage of the discriminatory facilities offered by the computer to test load requirements against available capacity, work is carried out backwards week by week until the total load is successfully absorbed.

The output of the computer at this plant loading stage comprises :

(*a*) A " Load Statement "—for the guidance of production management, showing the load on different shops, sections and machines week by week over the production period.

(*b*) Statement of requirements of jigs, tools, fixtures and other facilities for the carrying out of each operation—in other words a subsidiary load statement covering only these facilities.

(*c*) Operation job cards—for each operation on each part or assembly.

It will be appreciated, of course, that any resemblance between the load statement prepared by the computer and what actually happens on the shop floor will largely depend upon :

(1) Precise definition—on the operation job card and its accompanying documents—of what is to be done and when.

(2) Effective progressing of the work to see that it is carried out as prescribed—progress control.

Progress Control

The defining to the shops in precise terms what they are to do next week, how and in what order, is achieved by the issuing to them week by week of :

(*a*) That section of the load statement covering only work to be done next week. This is issued one week before the work is actually to be done.

(*b*) Operation job cards covering all jobs to be done next week. These are issued one day before the week in which the work is actually to be done.

(*c*) Drawings, layouts, batch label, material requisitions covering all aspects of the job for which the operations job cards are issued. The first three will accompany the job throughout its whole course from start to entry into store.

The operations job card is the key to the system of progress control. Four copies of this document—an interpreted punched card—are prepared in the computer room by gang punching from the original which constitutes the punched card output of the computer at the plant loading stage. Of these copies :

(*a*) Is retained in computer room.

(*b*) Is retained in central control room.

(*c*) Is issued to the timekeeper.

(*d*) Is the shop copy, issued to the foreman with necessary documents, batch label, &c.,

and constituting his authority to do the work.

When the first part of a batch has been machined and passed by inspection the shop card (*d*) is initialled as authority to proceed with the making of the batch. The batch being completed, it is passed in for inspection and counting, the results of which are entered by the inspector on the shop card. The job —with batch label, layout and drawings is then available for the next operation and a repetition of this procedure. The shop card, after each operation, is returned to central control room where the quantity passed good is noted and marked on control copy (*b*). The shop card is then passed to the timekeeper who marks quantity good on his own copy (*c*) and sends this to accounts for costing and other purposes.

The marked control room copy (*b*) is passed to computer room where the marking is punched into the card. The computer room now holds :

(1) Its own (*a*) copy of all operation job cards issued to the shops.

(2) Control room (*b*) copy of all operation job cards returned from the shops relating to the jobs completed at each stage of operation with quantity passed good punched therein.

A simple collation of (*a*) against (*b*) with the throwing out of unpaired cards, i.e. those representing jobs not yet completed, shows what jobs are behind programme. These are then listed, section by section in priority order, each section being supplied with a precise statement of jobs in that section which are behind programme. The section head is responsible for programming these jobs to ensure their speedy completion, or for reporting back to control room why this cannot be done, e.g. overload or breakdown. If conditions in any section become so serious that the work of other sections is likely to be held up, then reloading may be necessary. By manual or by conventional mechanised methods this might well be a major operation ; with the computer it presents but little difficulty. Since the shops are only concerned with the current and the following week's work, reloading is largely a matter of internal re-assessment within the control room and computer room. The shops need not even become aware of it. The operation job card for the last operation in the shop serves to book the part into store—by quantity.

Stock Control by Computer

With the aid of the computer an attempt is being made to develop an efficient system of stock control by :

(i) Projecting investigations into the future.

(ii) Taking account of more variables than is customary.

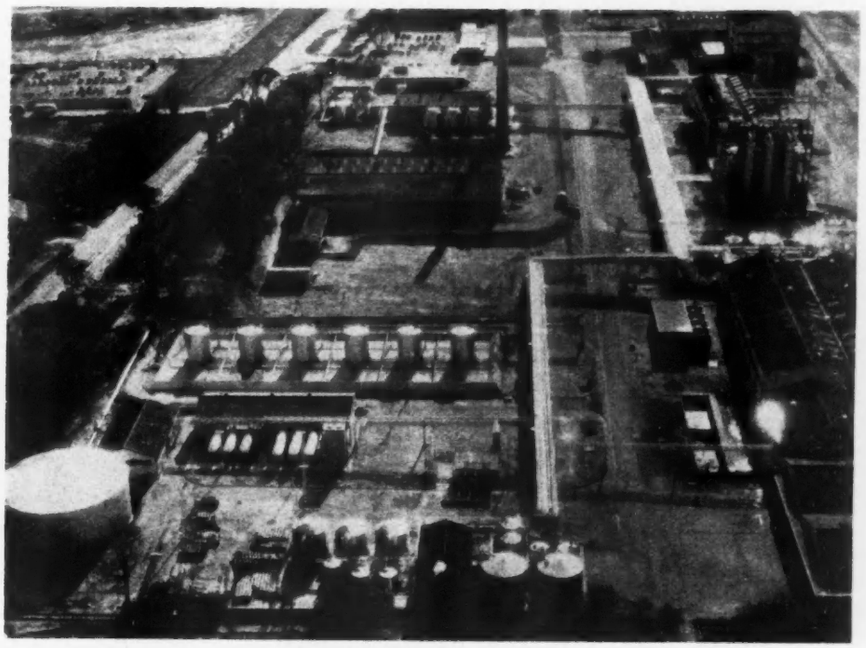
(iii) Indicating specifically only those items upon which some action must be taken, and what action.

The system being developed provides for :

(*a*) A weekly review of the position relative to stocks of raw materials ; of all other bought out items and of all long-term subcontracts. This review covers, by period, ten periods representing in all requirements for some twenty-one months ahead.

(*b*) A daily review of the position relative to stocks of all made-in items (piece-parts or assemblies), such review covering by period ten weekly periods.

The object of this procedure is to make weekly or daily adjustments (as the case may be) to stock records so that, by making use of the computer's discriminatory powers, decisions are automatically taken about dealing with any variations from programmed stocks either by absorption into the next order, or by immediate initiation of a new order.

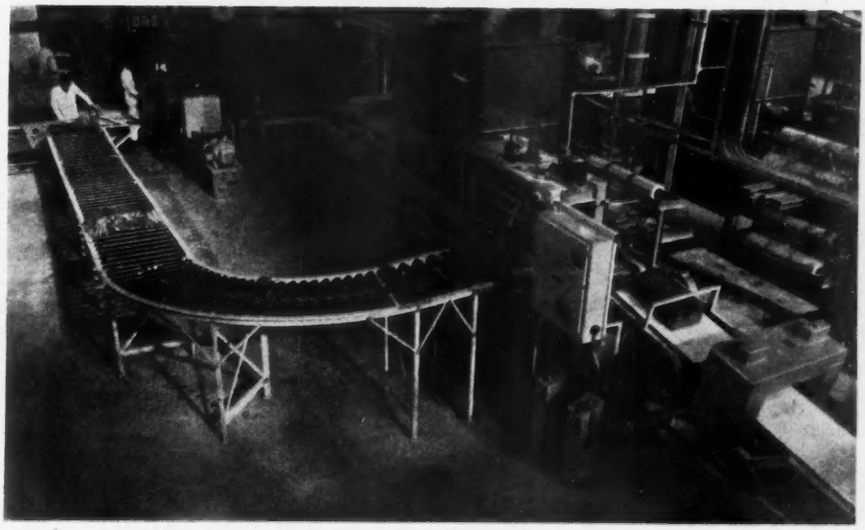


Synthetic Rubber Plant at Hythe

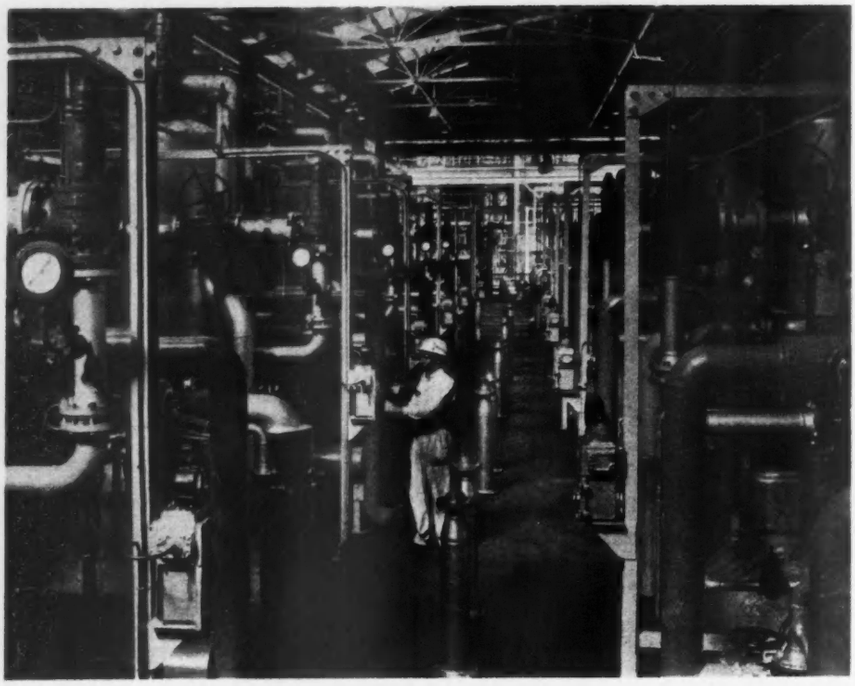
With the demand for rubber exceeding potential natural supplies there has been an increasing use of synthetic rubber which has had to be imported. Following experimental work, a synthetic rubber plant, with a capacity of up to 70,000 tons per annum, has been built at Hythe, on Southampton Water, the capital being provided by a consortium of major rubber users. Our illustration above shows the general layout of the plant, with the mixed chemicals tank farm in the foreground, then the water treatment plant and the styrene tank farm. To the right is the finishing building, and behind that is the recovery unit, the reactor building and the solution make-up block.

ON a site at Hythe, on Southampton Water, there has been completed recently a plant for the production of a large tonnage of general-purpose synthetic rubber, which is this country's first plant to manufacture this material in bulk. It has been built for the International Synthetic Rubber Company, Ltd., and its designed capacity of 70,000 tons per year means that Great Britain is now self-supporting in the matter of this material and, indeed, has a surplus for export. During the last two decades the demand for rubber has increased to a point where it greatly exceeds world potential production, so that the consumption of synthetic rubber has expanded enormously. Until now this country's requirements have had to be met by imports from the dollar area so that production at Hythe directly reduces the trade gap.

The installations cover about 280,000 square feet of the 54-acre site, with excellent road access and its own sidings on the Totton–Hythe–Fawley railway. They were built in a period of sixteen months. Production is planned to be continuous, day and



Rubber bale wrapping and bagging machines

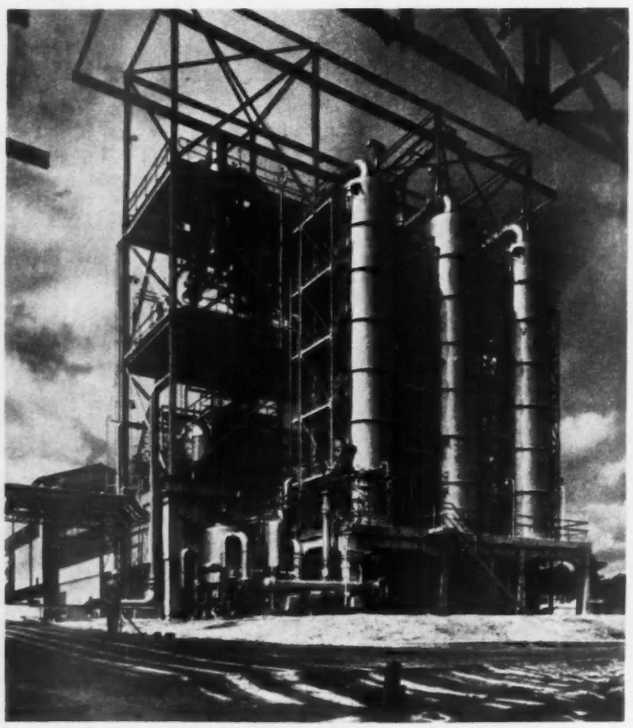


Operating floor in reaction building

night, throughout the year, and care has been taken to duplicate all essential units so as to avoid the possibility of breakdown. The brand name of the product is "Intol," of which there are three main grades, one of which is a rubber extended by a percentage of a special aromatic oil. Styrene and butadiene are the main ingredients, in the ratio of 1 to 3, the supplies of styrene being sent by road, rail and coastal tanker from Grangemouth and Partington, while the butadiene is piped a distance of 1¾ miles from the Fawley refinery of the Esso Petroleum Company, Ltd. The annual consumption of the foregoing materials is at the rate of 13,000 tons and 50,000 tons respectively.

Since the technical resources for the construction of such an undertaking were not available in Britain, the Blaw-Knox Company of Pittsburg was made responsible for the designing, installation and commissioning of the plant, while Matthew Hall and Co., Ltd., carried out the engineering work and John Laing and Co., Ltd., were the civil engineering contractors. Exploration of the site showed that part consisted of well-drained gravel and part of clay soil, having poor load-bearing qualities, in which Franki piles were driven to an average depth of 30ft, each being set to carry a load of 70 tons. Concrete footings foundations were used for the gravel soil. Steel-frame construction with asbestos cladding and glazing was employed for the process buildings and curtain-walled panelling for the administration buildings.

The plant is designed to produce general-purpose butadiene/styrene copolymers through the medium of a low-temperature, "cold," emulsion, polymerisation reaction, and for the storage of raw materials there are three tank farms, one for butadiene, with a capacity of 350,000 gallons ; another of 240,000 gallons capacity for styrene, and a third for mixed chemicals. There is storage for 120,000 gallons of process oil, 33,000 gallons of anti-oxidant, 125,000 gallons of latex, and 1,000,000 gallons of salt water, and also a solution make-up warehouse. The first stage in the process is carried out in the solution make-up buildings, where an emulsifier solution or soap is made up on the batch system, sodium hydrosulphate and potassium sulphate and other materials being mixed and dissolved in water, in tanks fitted with various forms of agitators and, in some instances, with heating coils. After preparation the solution is held in buffer storage tanks and then drawn off continuously to process, where it is charged together with butadiene and styrene to the reaction system. The butadiene is a blend of fresh and recycle material with the excess recycle butadiene being returned to the refinery for purification. From the tank farm the blended butadiene passes through a scrubber, where the inhibitor is watered out, and then pumped through surge tanks and metering systems to the reactor trains. Similarly, a blend of fresh styrene and recycle styrene is prepared and forwarded via surge tanks and metering systems to the reactor trains. The activator solution is prepared and pumped to the reactor trains and a similar procedure adopted for the modifier and the catalyst. The surge tanks are on the suction side of the pumps which deliver to the reactors, and the various solutions enter a single charge pipe which passes through sea-water-cooled heat exchangers and then via exchangers using refrigerated ammonia as a coolant. Thus the temperature of the feed stock is adjusted as required for the reaction. It is at this point that the activator is added in metered quantities.



Butadiene recovery plant and styrene stripping columns

The liquor then enters the first of a series of eleven reactors, illustrated herewith, in which the polymerisation takes place continuously at a rate controlled by the quantities of activator and catalyst solutions added while the plasticity of the polymer is controlled by the amount of modifier added to the charge. When a predetermined proportion, approximately 60 per cent. of the monomer charge has been reacted the polymerisation is halted by the addition of a short stop, which takes place at a series of displacement columns. The latex is then heated by steam in surge tanks and with this rise in temperature the vapour pressure of the unrecovered monomers is raised. For the recovery of the latter the hot latex enters the recovery system, illustrated herewith, when it passes into tanks where most of the butadiene is flashed off under pressure and then into other tanks where the remainder of the excess butadiene is flashed off under vacuum. The butadiene so recovered is compressed and condensed and pumped to the recycle storage tank. Next, the unreacted styrene is removed in columns, having open trays, by steam stripping under vacuum and the styrene vapour/steam is condensed, the styrene being separated from the water by decantation and pumped to recycle storage tanks. The stripped latex passes to storage tanks through glass-lined pipes.

From storage the latex is forwarded to blending tanks where, if an oil extended rubber is required, an oil emulsion is added. At this point an anti-oxidant emulsion is added to protect the rubber after coagulation when the wet crumb is being dried. Coagulation takes place under conditions of vigorous agitation, brine and acid are added to the latex, which curdles and the crumb and serum flow into a soap conversion tank, also agitated. The slurry overflows on to a vibratory screen, from which the coagulum falls into a leaching vat where it is washed.

From this vat the slurry overflows on to a rotary vacuum filter where the aqueous phase is removed by the vacuum and the action of three external rolls. The cake of rubber crumb is discharged into a hammer mill where it is broken down into crumb. This is blown to the top of one of four three-band dryers, each of which has nine zones with four fans to each. The top band is of stainless steel while the second and third are cadmium plated on one side and all are sprayed with a soap solution to prevent the crumb sticking while being dried at an average temperature of 200 deg. Fah. Steam tubular heaters warm the drying air.

The dried crumb, which has had its moisture content reduced from 50 to 0·5 per cent, is raised by elevator and then gravity fed to an automatic weighing machine which forwards 80 lb lots to a baling machine. The bales of compressed crumb pass on conveyors to a wrapping machine and then, sealed in a polythene sheet, continue along a roller conveyor to a bagging machine, as illustrated, and thence to storage.

Steam is provided by three John Thompson Integral boilers fitted with Peabody burners. For the cooling water system there are two Gwynne pumps, while for the fire services there are two Worthington-Simpson pumps. One pump of each group is powered by a Metropolitan-Vickers electric motor and the other is driven by an English Electric diesel engine.

Rolling Mill for Nuclear Fuel Elements

A rolling mill specially designed and built by Albert Mann's Engineering Company, Ltd., for rolling nuclear fuel elements has four sets of rolls which are interchangeable by a completely automatic system so that a full rolling sequence normally involving up to four machines can be carried out. The mill is designed for a "glove box" enclosure with all its operations controlled from a remote control desk. It has a maximum rolling load capacity of 600,000 lb at a speed of 100ft per minute.

THERE was recently demonstrated at the works of Albert Mann's Engineering Company, Ltd., Basildon Industrial Estate, Essex, a rolling mill specially designed and built by the firm for the Commissariat a l'Energie Atomique, for the processing of nuclear fuel elements. This mill of "Stanat/Mann" two-high/four-high combination construction is designed for installation in a "glove-box" enclosure of stainless steel and transparent plastics, with all its operations controlled remotely from outside the enclosure. Its enclosure, in addition to providing the necessary protection to operators, also enables the introduction of an inert gas at a small negative pressure when rolling materials such as plutonium which would otherwise suffer from oxidation. The mill has four interchangeable roll stands which will enable the production of fuel elements in a variety of shapes and configurations including flat, curved and corrugated plates; solid and hollow slugs; rods and tubes, and plate, slug, rod and tube assemblies. The use of four interchangeable stands on the one mill enables a rolling sequence on the single machine which could, under conventional practice, call for a two-high hot breakdown mill, a two-high cold intermediate mill, a four-high cold sheet finishing mill, and possibly a form rolling mill.

The new 10in diameter by 14in face width mill as assembled for test at the makers works can be seen in our illustrations. The mill is arranged for Ward-Leonard control and the prime mover is a Crompton Parkinson 1450 r.p.m., 0/420V, 191A shunt wound motor generator mounted on a common bedplate with the rest of the equipment.

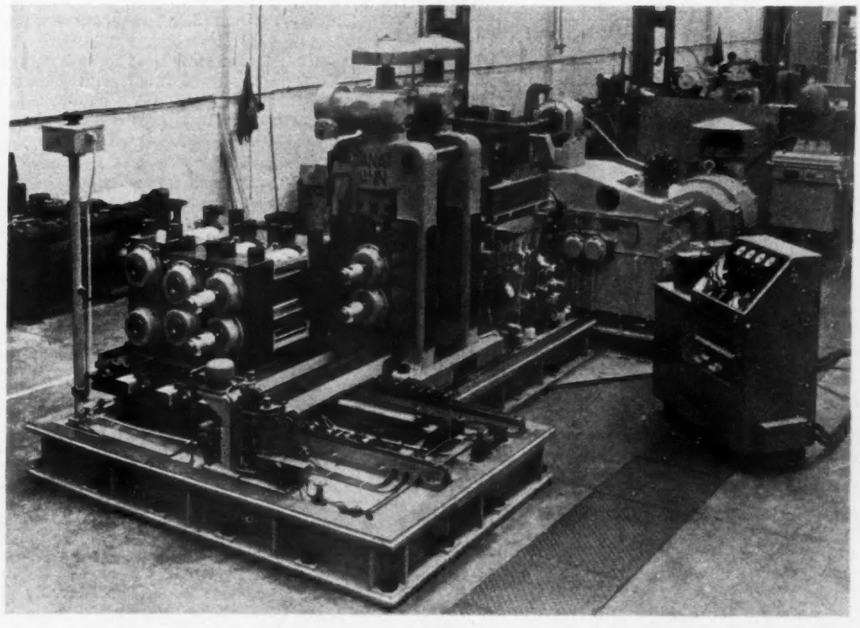
The mill drive comprising a double-helical reduction gear and pinion stand is coupled to the roll stand through universal joint spindles. This gearbox is driven by a Crompton Parkinson 26/100/100 h.p., 200/750/1500 r.p.m. separately excited motor. With this drive and Ward-Leonard control there is provided an 80ft–160ft per minute constant horsepower range and a 5ft–80ft per minute constant torque range. The mill is designed for a 600,000 lb maximum rolling load capacity at a speed of 100ft per minute.

As can be seen in the illustrations a transverse bed is fitted to the mill at the side of the housings opposite the drive equipment. A table carried on roller guide ways along this bed has four slides each of which is designed to carry one of the four sets of roll assemblies. The table is moved along the bed to align the required roll assembly slide with the mill housing by means of a hydraulic ram. When a roll slide is in line with the housing, a pinion at the end of the slide leadscrew automatically engages with a drive gear fixed at the side of the main bed. When the motor of this drive is started the leadscrew is turned to move the roll assembly into or out of the housings as required.

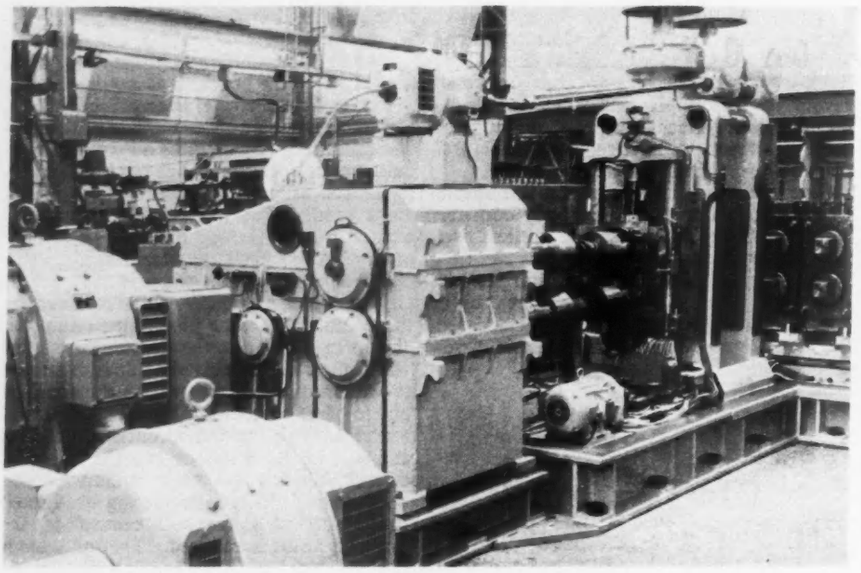
The complete roll changing sequence is controlled from a desk at the side of the mill and is started by depression of a single button once a selector switch has been turned to the roll assembly required. In the automatic sequence the screwdown is first disconnected from the top roll of the assembly in the housing, and the screwdown gear is elevated to a position where it will accept any roll configuration. This is followed by the withdrawal of the jibs which retain the chocks in position in the mill housings after which the roll assembly slide drive is started to withdraw the assembly from the housings on to the table. Whilst the withdrawal movement is being carried out a mechanism comes into effect to support the universal driving spindles and when withdrawal has been effected the spindle spacing is adjusted to comply with the roll centres of the assembly to be introduced. The roll table is then traversed to bring the selected assembly into line with the housings and the slide drive is engaged to move the assembly into the mill. When the assembly is in position it is locked by the jibs and the screwdown mechanism descends to engage automatically without major pressure being applied.

The rolls are adjusted by a 2 h.p. infinitely variable speed motor driving the screwdown spindles through a double worm reduction, a magnetic clutch being fitted to enable individual adjustment of each side of the mill to take place. The screwdown speeds are variable from 0·18mm per second for cold rolling, up to 2·6mm per second for hot rolling. This screwdown motor drive is situated outside the glove box enclosure because of the detrimental effect on the equipment if arcing should take place on the motor armature within an inert atmosphere.

A comprehensive system of instrumentation is fitted by which left-hand or right-hand roll pressure or the sum of both can be read at the control desk. These pressures are measured by load cells situated between the screwdown and the top roll chocks.



Rolling mill with four roll assemblies, any one of which can be selected and introduced into the housings by an automatic changing sequence on depression of a single push button on the control panel



Rear of the mill, showing the combined gearbox and pinion stand, with the universal couplings from the gearbox to the rolls. On these coupling spindles are mounted the torque measuring strain gauges

Measurement can also be made of the upper roll neck torque, lower roll neck torque and the sum of both. These torques are measured by strain gauges fitted on the universal driving spindles, their signals being transmitted via slip rings and brushes mounted on the universal joints. A two-pen high-speed recorder is provided at the control desk for recording roll pressure and roll neck torque.

The control equipment developed in the electronic laboratory of the makers of the mill is very flexible in operation over the required speed range, and is based on a new technique of pulse controlled thyratrons, for which patent application has been made. The pulse control method is used because it is independent of anode wave form, does not drive the grid positive at any time and, in consequence, an extremely stiff control of the firing angle may be obtained without the use of feed back control. The compact design of the electronic components makes it possible to incorporate in the control console the variable speed control for the mill drive, as well as the 2 h.p. variable speed screwdown motor control, all the relays, &c., associated with solenoid control of the hydraulic circuits. Also incorporated in the console are the amplification and recording equipment required for the torque and screwdown pressure system. It is claimed that the very high orders of speed stability and control obtained with this equipment enable close automatic control of tension and simplify the introduction of programme control.

Fast Pilot Launch "Leader"

THE fast pilot launch "Leader" recently paid a visit to the Thames and the opportunity was taken to take part in a short demonstration run intended to show its handling qualities. Described as an experimental craft, the design has been evolved jointly by Trinity House and John I. Thornycroft and Co., Ltd., and the boat was built at the latter company's Woolston yard at Southampton. The whole concept of the design is a considerable departure from previous Trinity House practice and provides for the launch to go alongside large ships and tranship pilots under open sea conditions and in all weathers. The extent of the departure from current practice will be more readily realised when it is noted that the launch has a length overall of 70ft by 15ft beam by 4ft 6in draught, and is handled by a crew of four, compared with the cutters, at present in use, of between 350 and 650 gross tons, of which there are eight, and each requiring a crew of about seventeen. This new craft of moderate dimensions offers considerable savings in both first cost and running costs and also a shorter time at sea for the pilots. The launch entered the London and Isle of Wight Pilotage Service in July of last year and since then has carried out 736 transhipments, mostly on the Needles station. She has proved to be an excellent sea boat and has never had to be withdrawn because of weather conditions without the cruising cutter being withdrawn through the same cause.

The general appearance of the launch can be seen in our illustration and the hull is constructed of double-skin diagonal planking with oiled fabric between the skins. External protective belting is fitted and the outer skin is $\frac{3}{4}$in thick and the inner $\frac{1}{4}$in thick, while non-slip tread strips, 6in wide, are laid transversely to port and starboard on the foredeck to provide a safe surface for the pilots. Underwater surfaces are cathodically protected.

At the forward end of the launch is the fore peak, to which a small watertight hatch abaft the breakwater on the foredeck gives access. Within the space is the chain locker and there is a hand suction bilge pump fitted. The next compartment is a large store, fitted with batten shelves, over which is a large lift-off hatch. Aft of the store and almost amidships is the engine-room which is entered through a hinged hatch at the forward end of the wheelhouse and over which is a large skylight, a section of which serves as an escape hatch. A ladderway, on the centre line, at the aft end of the wheelhouse leads to the saloon which provides excellent accommodation for the pilots. Comfortable settees are fitted fore and aft, to seat twelve pilots or provide space for six to lie down, and forward to port is a small galley, the matching compartment to starboard being a toilet. Ventilation is by two supply and two exhaust natural ventilators, while heating of the compartment is by warm air trunked from a Smith's combustion heater mounted to starboard at the aft end of the engine-room. The aft peak houses the steering gear for the twin rudders and also serves as a store. Good all-round vision is obtained from the wheelhouse which has an 11in diameter Kent clear view screen fitted in each of the forward windows, and is equipped with Pye v.h.f. and Marconi "Seamew II" radio telephones and Decca 212 radar. The steering position is on the centre line and in addition to the helmsman's seat there is a seat on each side of the stairway down to the saloon. Mounted on the roof of the wheelhouse are the radar scanner, loud-hailer and searchlight, and immediately aft is a telescopic mast.

The launch is propelled at 16 knots by two Rolls-Royce mark C.8.SFLM supercharged, four stroke, direct injection compression ignition engines rated to develop 296 b.h.p. at 1700 r.p.m. Each unit has eight cylinders of $5\frac{1}{8}$in bore by 6in stroke and a compression ratio of 14 to 1. The fuel system consists of twin piston lift pumps, incorporating hand priming levers, a jerk pattern injection pump with hydraulic all-speed governor, while the lubrication system is by semi-dry sump with pack heat exchanger. Full flow filters are fitted, also low oil pressure warning and a sump and gearbox evacuation pump. Cooling is by sea water circulated by a centrifugal pump through the engine coolant heat exchanger, two charge coolers and the gearbox oil cooler, and some of the sea water is discharged into the twin exhaust pipes to cool the exhaust gases. The engine coolant is circulated by a belt-driven centrifugal pump and the flow through the heat exchanger is controlled by a thermostatically operated valve. A positive displacement gear-driven Roots pattern blower is mounted on the crankcase and the final drive is through a Thornycroft "B" reverse reduction gear with a 2 to 1 ratio, the power output from the gearbox being 280 b.h.p. As the engines are not handed the port gearbox is engine rotation, while the starboard unit is anti-engine rotation, so that the propellers are outboard rotating when going ahead. "Bloctube" controls are fitted. On the centre line forward is a 1½kW generator driven by a Lister air cooled engine which also powers a bilge pump and a wash-down pump. Fuel is carried in two 250-gallon tanks, one to port and one to starboard, while aft to port is a 50-gallon fresh water tank and forward to starboard is a 25-gallon lubricant tank.

Trinity House pilot launch "Leader"

SHORTER REPORTS

Eynsham Bridge

LAST week, an opening ceremony was held to inaugurate the road viaduct known as Eynsham Bridge, which gives access to the London County Council's Abbey Estate. The estate covers about 260 acres in north-east Woolwich, bordering on the Thames and the county boundary with Kent. When it is completed in 1961, it will provide new houses and flats for about 2700 London families ; two primary schools for 1120 children ; a secondary school for 1260 boys and girls ; six houses for children in the Council's care ; a home for sixty old and infirm people ; a main centre for shops, library, health centre and estate office, with sites reserved for a church and a public house ; and a smaller shopping centre. Eighteen acres have been set aside for open space and play. Housing and civil engineering work is estimated to cost about £6,000,000.

Eynsham bridge, in north-east Woolwich, has seven 70ft spans. Some of the new buildings of the Abbey estate, to which the bridge gives access, may be seen

Considerable difficulties in the development, due to the area being low-lying, have been overcome. Because of the nature of the sub-soil, special types of foundation had to be designed to suit the different types of buildings and the danger of flooding has been eliminated by the raising and widening of the river wall by the Kent River Board, and the L.C.C. has built a new pumping station at a cost of £26,364, containing five electrically-driven pumping sets (two for sewage and three for storm water).

Eynsham Bridge has been built at a cost of approximately £220,000 to provide the main access to the estate. The viaduct is of reinforced concrete construction. It has seven slender spans, each 70ft long, carried on groups of 3ft diameter columns. The carriageway is 30ft wide. Partly cantilevered, 8ft wide, footways run on either side. The external concrete face of the outer arched beams has been given a bush-hammered finish. Hand-railing is in wrought iron and is painted white to give an appearance of lightness. The carriageway and footways in the approaches to the viaduct are carried on embankments, the side slopes of which are to be grassed. The total length of the viaduct and approaches is approximately 1300ft. The work has been designed and supervised by Messrs. Howard Humphreys and Sons, consulting engineers, and has been carried out by W. and C. French, Ltd.

Licensing and Insurance of Nuclear Installations

THE Nuclear Installations (Licensing and Insurance) Bill was introduced by the Minister of Power, Lord Mills, and had its first reading in the House of Lords last week. The Bill has two main aims. The first is, in the interests of safety to control, to license the building and operation of nuclear reactors and other fixed nuclear installations as may be prescribed ; licensing will not extend to installations of the Atomic Energy Authority or to Government departments. The second aim of the Bill is to impose on any licensee for building or operating a nuclear installation an absolute liability for all hurt to persons or damage to property caused by radiation arising from the site even though it may be due to unavoidable accident. To give effect to this obligation the licensee is required to take out cover by insurance or other means up to £5,000,000 " for any one occurrence on any one site." If the liability for any occurrence appears likely to exceed £5,000,000, Parliament is given an opportunity to reconsider the position. A similar liability, but without any obligation to insure against it and without further reference to Parliament, is placed on Government departments.

The licensing system is defined in clause 1 of the Bill. The licensing authority is the Minister of Power (in Scotland the Secretary of State and in Northern Ireland the Minister of Commerce for Northern Ireland). Safety measures to be taken by the licensee will be laid down in the conditions of the licence. But disposal of radioactive wastes will be determined by authorisations of the Minister of Agriculture, Fisheries and Food (in Scotland the Secretary of State) in the same way as the Atomic Energy Authority Act, 1954, relates to the Atomic Energy Authority. The Minister will have power to revoke a licence for a nuclear site and to give directions for preventing radioactive danger from disused plant while any risk remains.

A licensee's liability to third parties for hurt or damage by radiation from anything on the site, from waste discharged from the site and from irradiated fuel carried between places in the United Kingdom is defined in clause 3 of the Bill. Common law liability is to be replaced by a liability which is absolute and regardless of negligence on the part of the licensee. This liability is to rest on the licensee alone to the exclusion of all other persons. However the licensee will not be liable for hurt or damage attributable to enemy action. Claims must be made within ten years.

The licensee's cover, whether by insurance or otherwise, must be approved by the Minister with the consent of the Treasury and its relation to particular occurrences is secured by a system of " cover periods." The Minister is to be empowered to order reinstatement of cover after a serious occurrence. If a licensee has more than two nuclear sites to be covered, otherwise than by insurance, he will not be bound to hold cover for more than two sites unless the Minister directs otherwise.

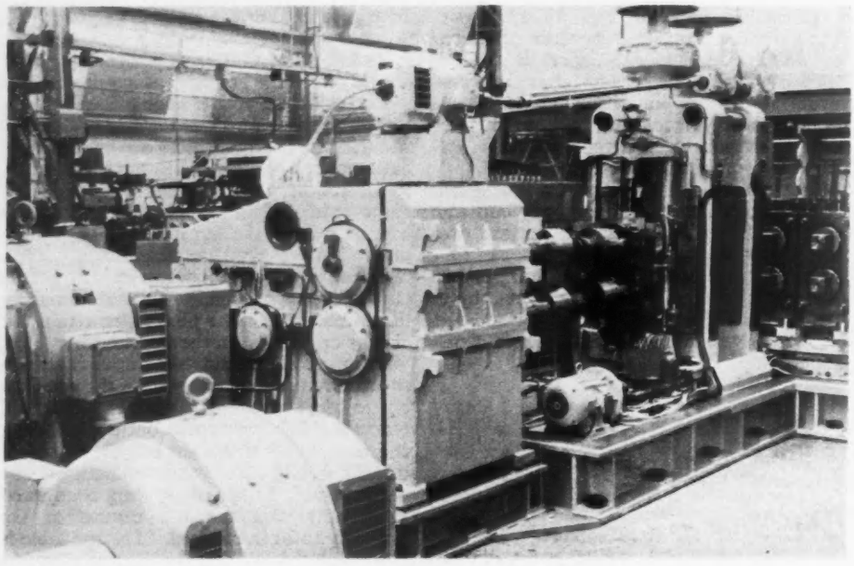
If the Minister considers that the licensee's liability from any occurrence is likely to exceed £5,000,000, he is required to certify it by statutory declaration ; thereafter no further claims relative to that occurrence are to be dealt with until determined by Parliament.

Penalties for offences are dealt with in clause 7 of the Bill.

Provisions of the Bill that are applicable to Government Departments and the Atomic Energy Authority are given in clause 8 of the Bill. These bodies will not be subject to licensing but they will be under an absolute liability to third parties irrespective of the amount of the claims, even if the occurrence is attributable to enemy action. Claims will have to be presented within ten years. Unlike licensees, Government departments and the A.E.A. will have a right of recourse against persons whose negligence may have given rise to third party claims except where the claims are concerned with radiation arising from the carriage of irradiated nuclear fuel.

Fuel Research

THE report of the Fuel Research Board for 1957 says that, following a careful examination of the present pattern of fuel research in Great Britain, a recommendation has been made that only two main items of research should be transferred from the existing Fuel Research Station at Greenwich to the new Warren Spring Laboratory at Stevenage. These are the programmes of work concerned with the measurement and abatement of air pollution and with the synthesis of oil from carbon monoxide and hydrogen which are obtained from the gasification of coal. The report explains how the state of fuel research has changed since the station was established at Greenwich in 1917. At that time there was a need for the station to cover the whole field of research on solid, liquid and gaseous fuels. Since then, however, the pioneer work of the station has led to the growth of other organisations for research on fuels. The intention is that the new laboratory at Stevenage shall be the centre of research in this country on air pollution. Work will be carried out on the reduction of pollution



Rear of the mill, showing the combined gearbox and pinion stand, with the universal couplings from the gearbox to the rolls. On these coupling spindles are mounted the torque measuring strain gauges

Measurement can also be made of the upper roll neck torque, lower roll neck torque and the sum of both. These torques are measured by strain gauges fitted on the universal driving spindles, their signals being transmitted via slip rings and brushes mounted on the universal joints. A two-pen high-speed recorder is provided at the control desk for recording roll pressure and roll neck torque.

The control equipment developed in the electronic laboratory of the makers of the mill is very flexible in operation over the required speed range, and is based on a new technique of pulse controlled thyratrons, for which patent application has been made. The pulse control method is used because it is independent of anode wave form, does not drive the grid positive at any time and, in consequence, an extremely stiff control of the firing angle may be obtained without the use of feed back control. The compact design of the electronic components makes it possible to incorporate in the control console the variable speed control for the mill drive, as well as the 2 h.p. variable speed screwdown motor control, all the relays, &c., associated with solenoid control of the hydraulic circuits. Also incorporated in the console are the amplification and recording equipment required for the torque and screwdown pressure system. It is claimed that the very high orders of speed stability and control obtained with this equipment enable close automatic control of tension and simplify the introduction of programme control.

Fast Pilot Launch "Leader"

THE fast pilot launch "Leader" recently paid a visit to the Thames and the opportunity was taken to take part in a short demonstration run intended to show its handling qualities. Described as an experimental craft, the design has been evolved jointly by Trinity House and John I. Thornycroft and Co., Ltd., and the boat was built at the latter company's Woolston yard at Southampton. The whole concept of the design is a considerable departure from previous Trinity House practice and provides for the launch to go alongside large ships and tranship pilots under open sea conditions and in all weathers. The extent of the departure from current practice will be more readily realised when it is noted that the launch has a length overall of 70ft by 15ft beam by 4ft 6in draught, and is handled by a crew of four, compared with the cutters, at present in use, of between 350 and 650 gross tons, of which there are eight, and each requiring a crew of about seventeen. This new craft of moderate dimensions offers considerable savings in both first cost and running costs and also a shorter time at sea for the pilots. The launch entered the London and Isle of Wight Pilotage Service in July of last year and since then has carried out 736 transhipments, mostly on the Needles station. She has proved to be an excellent sea boat and has never had to be withdrawn because of weather conditions without the cruising cutter being withdrawn through the same cause.

The general appearance of the launch can be seen in our illustration and the hull is constructed of double-skin diagonal planking with oiled fabric between the skins. External protective belting is fitted and the outer skin is $\frac{3}{4}$in thick and the inner $\frac{1}{2}$in thick, while non-slip tread strips, 6in wide, are laid transversely to port and starboard on the foredeck to provide a safe surface for the pilots. Underwater surfaces are cathodically protected.

At the forward end of the launch is the fore peak, to which a small watertight hatch abaft the breakwater on the foredeck gives access. Within the space is the chain locker and there is a hand suction bilge pump fitted. The next compartment is a large store, fitted with batten shelves, over which is a large lift-off hatch. Aft of the store and almost amidships is the engine-room which is entered through a hinged hatch at the forward end of the wheelhouse and over which is a large skylight, a section of which serves as an escape hatch. A ladderway, on the centre line, at the aft end of the wheelhouse leads to the saloon which provides excellent accommodation for the pilots. Comfortable settees are fitted fore and aft, to seat twelve pilots or provide space for six to lie down, and forward to port is a small galley, the matching compartment to starboard being a toilet. Ventilation is by two supply and two exhaust natural ventilators, while heating of the compartment is by warm air trunked from a Smith's combustion heater mounted to starboard at the aft end of the engine-room. The aft peak houses the steering gear for the twin rudders and also serves as a store. Good all-round vision is obtained from the wheelhouse which has an 11in diameter Kent clear view screen fitted in each of the forward windows, and is equipped with Pye v.h.f. and Marconi "Seamew II" radio telephones and Decca 212 radar. The steering position is on the centre line and in addition to the helmsman's seat there is a seat on each side of the stairway down to the saloon. Mounted on the roof of the wheelhouse are the radar scanner, loud-hailer and searchlight, and immediately aft is a telescopic mast.

The launch is propelled at 16 knots by two Rolls-Royce mark C.8.SFLM supercharged, four stroke, direct injection compression ignition engines rated to develop 296 b.h.p. at 1700 r.p.m. Each unit has eight cylinders of $5\frac{1}{4}$in bore by 6in stroke and a compression ratio of 14 to 1. The fuel system consists of twin piston lift pumps, incorporating hand priming levers, a jerk pattern injection pump with hydraulic all-speed governor, while the lubrication system is by semi-dry sump with pack heat exchanger. Full flow filters are fitted, also low oil pressure warning and a sump and gearbox evacuation pump. Cooling is by sea water circulated by a centrifugal pump through the engine coolant heat exchanger, two charge coolers and the gearbox oil cooler, and some of the sea water is discharged into the twin exhaust pipes to cool the exhaust gases. The engine coolant is circulated by a belt-driven centrifugal pump and the flow through the heat exchanger is controlled by a thermostatically operated valve. A positive displacement gear-driven Roots pattern blower is mounted on the crankcase and the final drive is through a Thornycroft "B" reverse reduction gear with a 2 to 1 ratio, the power output from the gearbox being 280 b.h.p. As the engines are not handed the port gearbox is engine rotation, while the starboard unit is anti-engine rotation, so that the propellers are outboard rotating when going ahead. "Bloctube" controls are fitted. On the centre line forward is a $1\frac{1}{2}$kW generator driven by a Lister air cooled engine which also powers a bilge pump and a wash-down pump. Fuel is carried in two 250-gallon tanks, one to port and one to starboard, while aft to port is a 50-gallon fresh water tank and forward to starboard is a 25-gallon lubricant tank.

Trinity House pilot launch "Leader"

SHORTER REPORTS

Eynsham Bridge

LAST week, an opening ceremony was held to inaugurate the road viaduct known as Eynsham Bridge, which gives access to the London County Council's Abbey Estate. The estate covers about 260 acres in north-east Woolwich, bordering on the Thames and the county boundary with Kent. When it is completed in 1961, it will provide new houses and flats for about 2700 London families ; two primary schools for 1120 children ; a secondary school for 1260 boys and girls ; six houses for children in the Council's care ; a home for sixty old and infirm people ; a main centre for shops, library, health centre and estate office, with sites reserved for a church and a public house ; and a smaller shopping centre. Eighteen acres have been set aside for open space and play. Housing and civil engineering work is estimated to cost about £6,000,000.

Eynsham bridge, in north-east Woolwich, has seven 70ft spans. Some of the new buildings of the Abbey estate, to which the bridge gives access, may be seen

Considerable difficulties in the development, due to the area being low-lying, have been overcome. Because of the nature of the sub-soil, special types of foundation had to be designed to suit the different types of buildings and the danger of flooding has been eliminated by the raising and widening of the river wall by the Kent River Board, and the L.C.C. has built a new pumping station at a cost of £26,364, containing five electrically-driven pumping sets (two for sewage and three for storm water).

Eynsham Bridge has been built at a cost of approximately £220,000 to provide the main access to the estate. The viaduct is of reinforced concrete construction. It has seven slender spans, each 70ft long, carried on groups of 3ft diameter columns. The carriageway is 30ft wide. Partly cantilevered, 8ft wide, footways run on either side. The external concrete face of the outer arched beams has been given a bush-hammered finish. Hand-railing is in wrought iron and is painted white to give an appearance of lightness. The carriageway and footways in the approaches to the viaduct are carried on embankments, the side slopes of which are to be grassed. The total length of the viaduct and approaches is approximately 1300ft. The work has been designed and supervised by Messrs. Howard Humphreys and Sons, consulting engineers, and has been carried out by W. and C. French, Ltd.

Licensing and Insurance of Nuclear Installations

THE Nuclear Installations (Licensing and Insurance) Bill was introduced by the Minister of Power, Lord Mills, and had its first reading in the House of Lords last week. The Bill has two main aims. The first is, in the interests of safety to control, to license the building and operation of nuclear reactors and other fixed nuclear installations as may be prescribed ; licensing will not extend to installations of the Atomic Energy Authority or to Government departments. The second aim of the Bill is to impose on any licensee for building or operating a nuclear installation an absolute liability for all hurt to persons or damage to property caused by radiation arising from the site even though it may be due to unavoidable accident. To give effect to this obligation the licensee is required to take out cover by insurance or other means up to £5,000,000 " for any one occurrence on any one site." If the liability for any occurrence appears likely to exceed £5,000,000, Parliament is given an opportunity to reconsider the position. A similar liability, but without any obligation to insure against it and without further reference to Parliament, is placed on Government departments.

The licensing system is defined in clause 1 of the Bill. The licensing authority is the Minister of Power (in Scotland the Secretary of State and in Northern Ireland the Minister of Commerce for Northern Ireland). Safety measures to be taken by the licensee will be laid down in the conditions of the licence. But disposal of radioactive wastes will be determined by authorisations of the Minister of Agriculture, Fisheries and Food (in Scotland the Secretary of State) in the same way as the Atomic Energy Authority Act, 1954, relates to the Atomic Energy Authority. The Minister will have power to revoke a licence for a nuclear site and to give directions for preventing radioactive danger from disused plant while any risk remains.

A licensee's liability to third parties for hurt or damage by radiation from anything on the site, from waste discharged from the site and from irradiated fuel carried between places in the United Kingdom is defined in clause 3 of the Bill. Common law liability is to be replaced by a liability which is absolute and regardless of negligence on the part of the licensee. This liability is to rest on the licensee alone to the exclusion of all other persons. However the licensee will not be liable for hurt or damage attributable to enemy action. Claims must be made within ten years.

The licensee's cover, whether by insurance or otherwise, must be approved by the Minister with the consent of the Treasury and its relation to particular occurrences is secured by a system of " cover periods." The Minister is to be empowered to order reinstatement of cover after a serious occurrence. If a licensee has more than two nuclear sites to be covered, otherwise than by insurance, he will not be bound to hold cover for more than two sites unless the Minister directs otherwise.

If the Minister considers that the licensee's liability from any occurrence is likely to exceed £5,000,000, he is required to certify it by statutory declaration ; thereafter no further claims relative to that occurrence are to be dealt with until determined by Parliament.

Penalties for offences are dealt with in clause 7 of the Bill.

Provisions of the Bill that are applicable to Government Departments and the Atomic Energy Authority are given in clause 8 of the Bill. These bodies will not be subject to licensing but they will be under an absolute liability to third parties irrespective of the amount of the claims, even if the occurrence is attributable to enemy action. Claims will have to be presented within ten years. Unlike licensees, Government departments and the A.E.A. will have a right of recourse against persons whose negligence may have given rise to third party claims except where the claims are concerned with radiation arising from the carriage of irradiated nuclear fuel.

Fuel Research

THE report of the Fuel Research Board for 1957 says that, following a careful examination of the present pattern of fuel research in Great Britain, a recommendation has been made that only two main items of research should be transferred from the existing Fuel Research Station at Greenwich to the new Warren Spring Laboratory at Stevenage. These are the programmes of work concerned with the measurement and abatement of air pollution and with the synthesis of oil from carbon monoxide and hydrogen which are obtained from the gasification of coal. The report explains how the state of fuel research has changed since the station was established at Greenwich in 1917. At that time there was a need for the station to cover the whole field of research on solid, liquid and gaseous fuels. Since then, however, the pioneer work of the station has led to the growth of other organisations for research on fuels. The intention is that the new laboratory at Stevenage shall be the centre of research in this country on air pollution. Work will be carried out on the reduction of pollution

from furnaces or other appliances, on the chemical reactions of pollutants in the atmosphere and on dispersal and convective processes in the atmosphere. The co-operative scheme for the measurement of pollution, together with the collection and analysis of the data, will also be continued.

The report goes on to say that this country's dependence on imported petroleum products emphasises the national importance of developing an economic process for converting coal into liquid and gaseous fuels. A few years ago it was difficult to foresee the availability of coal for such a process, but with the rapidly developing use of nuclear energy it is now possible to envisage a future surplus of low-grade coal of the kind now consumed by power stations. Such coal could be converted into liquid fuels and town gas by a combination of gasification and Fischer-Tropsch synthesis. For the synthesis stage the liquid-phase (slurry) technique shows the greatest promise, and work on this kind of synthesis will be continued at Stevenage up to pilot-plant scale.

For smoke measurement, it is stated, a small portable instrument, which can be used in place of the Ringelmann chart, is being developed. In principle, the new instrument consists of a small telescope containing a number of translucent screens, darkened to standard shades, with which the smoke can be compared. In one model two screens corresponding to Ringelmann No. 2 and No. 3 shades are fitted in the body of the telescope and arranged so that they are seen, one above the other, in half of the field of view. The image of the smoke is seen directly in the other half and is in the same plane as the screens. The telescope is held so that the screens are seen against the same background as the smoke.

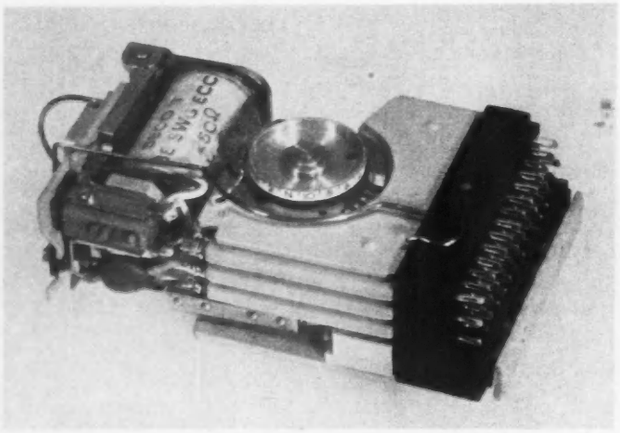
During last year, scientists completed the first phase of road tests being made to determine the effectiveness of a catalytic combustion unit as a means of reducing the amounts of combustible constituents of the exhaust gases from motor vehicles. The report notes that the catalyst was effective over the full range of conditions and, on average, reduced the percentage of carbon monoxide in the exhaust gas by about 85 per cent and the hydrogen by about 80 per cent. After the vehicle had covered some 11,000 miles there was a small but definite decrease in the performance of the catalyst.

Miniature Uniselector for Automatic Switching

THE accompanying illustration shows a small uniselector switch (measuring 3¼in by 2 $\frac{5}{16}$in by 1 $\frac{5}{32}$in) which has thirty-six outlets and has been developed by Siemens Edison Swan, Ltd., 155, Charing Cross Road, London, W.C.2, for use in automatic switching systems, where selection, registration and outlet marking is required. This uniselector (designation "2250") in its standard forms is suitable for either 22V or 50V circuits and a spark suppressor is incorporated. The whole unit is designed to operate for 2,000,000 revolutions without readjustment and to have a working life of at least 8,000,000 revolutions before replacement of any part is required.

The "2250" uniselector consists of three main parts: a driving mechanism and wiper assembly; a bank of contacts over which the wipers search at 60 steps a second; and a jack which is pre-wired and assembled to the mounting enabling the uniselector mechanism to be plugged in and out without disturbing any wiring. The driving mechanism is mounted on a steel side plate and all parts are readily accessible. It is operated by a ratchet and pawl "reverse drive" system having a single driving magnet and a single-break-action interrupter spring set with tungsten contacts. The wiper assembly comprises three pairs of nickel silver treble-ended wipers, either bridging or non-bridging. There is a number disc.

The outlet bank consists of thirty-six contact segments arranged in three levels. The design is such that one of the arms of the wiper assembly is always touching a specially fitted solid contact segment; this arrangement enables feeder springs to be dispensed with. All wiring terminations to both the driving mechanism and the contact bank are made through a 42-point plug and jack. When plugged in, the uniselector is securely held in position by a spring clip.



Miniature uniselector (3¼in by 2 $\frac{5}{16}$in by 1 $\frac{5}{32}$in) for automatic switching systems. It consists of electromagnetic drive mechanism, contact bank and pre-wirable jack with thirty-six outlets

Marine Engine Building

NORTH EASTERN MARINE ENGINEERING COMPANY, Ltd., which is one of the Richardsons Westgarth Group of Companies, has concluded an agreement with AB Götaverken of Gothenburg under which North Eastern Marine's range of production will now include the Götaverken design of diesel engines for marine and land use. North Eastern Marine's rights are on an exclusive basis as regards the British Commonwealth and on a non-exclusive basis for a number of other countries.

The arrangement also extends to Götaverken's designs of combined exhaust gas boilers and silencers.

The types of engines covered by this agreement have a range of powers for main and auxiliary purposes up to 22,000 b.h.p. The main engines are single-acting, two-stroke cycle, crosshead units with cylinders longitudinally scavenged, each cylinder having one exhaust gas valve in the cover. Scavenging is by two double acting pumps for each working cylinder built into the engine entablature and driven from the crosshead.

For supercharged engines the constant pressure system is employed, retaining the existing scavenge pumps which are coupled in series with the turbo-blower. A pressure-pulse turbine, we are advised, results in increased exhaust valve temperatures.

Turbine by-pass valves allow the engine to be run normally aspirated. While the maximum output per cylinder in a normally aspirated Götaverken diesel is 935 b.h.p. the supercharger has made it possible to raise this to 1250 b.h.p. A twelve-cylinder unit of 760mm bore by 1500mm stroke will thus have an output of 15,000 b.h.p. Napier or Brown-Boveri turbo-chargers are used.

A larger engine of 850mm cylinder bore by 1700mm stroke is under construction. Turbo-charged it will have a maximum output of 22,000 b.h.p. from twelve cylinders. The prototype will be delivered in 1960.

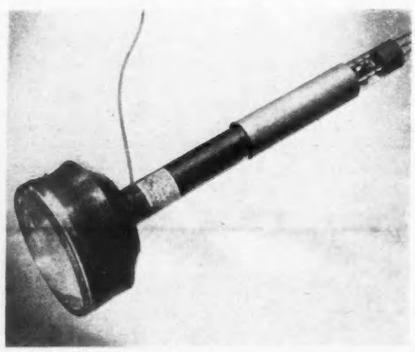
The auxiliary engines are of the four-stroke type with o.h.c. One important design feature of this engine is the use of a combined fuel injection pump and valve, eliminating pipes between fuel pump and valves. The present range covers outputs from 75–240kW.

The agreement excludes the high-speed opposed-piston two-stroke: N.E.M. are licensed to build Doxford opposed-piston main engines.

Micro-Spot Cathode-Ray Tube

A MICRO-SPOT cathode-ray tube (designated 5/71CM) which is claimed to be unique in its ability to resolve 5000 lines has been introduced by Ferranti, Ltd., Hollinwood, Lancs. With its spot diameter of "considerably less than 0·001in" the tube has been specially developed for airborne applications such as aerial mapping. The high resolution of the tube is made possible by the use of an unusually fine screen and a novel design of electron gun using two focusing elements, one of which is electromagnetic and external to the tube, while the other is electrostatic and of fixed focal length.

The tube (illustrated here) has an optical flat face of 5in diameter with a non-darkening glass and a short cylindrical bulb, coated—except over the screen surface—with a thick layer of plastic resin, enabling it to be operated under adverse atmospheric conditions, namely 30kV at 75,000ft



Micro-spot cathode-ray tube designed to be capable of resolving 5000 lines. It has been developed primarily for airborne applications such as aerial mapping

without danger of e.h.t. breakdown. No tube socket is required, the leads to the rear end of the tube being encapsulated in a way which does not hinder the tube from being mounted easily in its focus and scanning assembly.

Although the new tube is primarily intended for the display or photography of repetitive information, single transients may be photographed at writing speeds which are limited by the scan coil requirements. The standard phosphor used in the tube has green fluorescence, decaying to 1/e level within 10 microseconds after removal of excitation. It is also suitable for use with many kinds of photographic material. Tubes with a blue fluorescence can also be supplied.

The manufacturer states that great care must be taken in considering the quality of e.h.t., scanning and focus supplies for the tube, since multiple effects due to e.h.t. ripple, imperfect focusing and poor scanning fields can cause such an enlargement of the spot that no advantage is apparent when using these tubes. Scanning and focus coils specially designed for use with the 5/71CM tube, can be supplied by the maker, together with a small alignment magnet which is clamped to the neck of the tube in the region of the cathode.

British Motor Show in Lisbon

AT the Lisbon Trade Fair which is due to be held from May 29 to June 14, 1959, there will be an all-British Motor Exhibition in which all major British motor vehicle manufacturers are expected to take part. The show will include cars, commercial vehicles, agricultural tractors, accessories and components, and transport service equipment. In addition to the motor industry, the following industries will take part, according to British Overseas Fairs, Ltd., exhibition organisers on behalf of the Federation of British Industries: iron and steel; shipbuilding, electrical engineering, diesel engines and air and shipping lines.

Westfield Opencast Coal Site

THE Westfield site, on the borders of Fife and Kinross, about 2½ miles south-east of Loch Leven, is the largest opencast coal mining operation to be planned in Britain. The National Coal Board says that the reserves of 25,000,000 tons of coal are sufficient to keep the site active for more than twenty years, and the workings will eventually penetrate to a depth more than twice as great as any yet achieved in this country. Work on the site is still in the development stage. The coal preparation plant and ancillary installations, capable of handling 1,000,000 tons of coal a year, are now nearing completion, and already over 4,000,000 cubic yards of peat and sand have been pumped from the surface of the coaling area. The site covers an area of about 920 acres, but the greater part of this will be used only for dumping the earth moved from above the coal seams and for the coal preparation plant and other buildings ; the actual coaling area extends over about 270 acres. There are four main seams to be worked, each consisting of a considerable number of leaves of varying quality. The seams outcrop on the western edge of the coaling area, dip steeply towards the centre of the area, and then rise more gradually towards the eastern edge. The dip is steeper in the north, where the ground is higher, and where the maximum depth to the lowest seam is about 800ft.

Before the development of the site could proceed, a number of services had to be diverted to clear the area. These included a public road which now passes south of the site, a 26in water main which was diverted to the north, and the Lochty Burn, which ran through the centre of the area, and is now flowing through a new channel along the southern side of the site. Power and telephone lines were also diverted. The southern part of the area is low lying, liable to flooding, and consists mainly of peat. Large embankments were constructed in the south-eastern corner of the site to contain the peat, material for these embankments being excavated from the coaling area. Because of its nature, it was decided that the best method of removing the peat would be to dredge it and pump it to the disposal area ; to do this the area was flooded and on the artificial lake thus formed a dredger was floated. The dredger, illustrated herewith, has a revolving cutter head 7½ft in diameter. This cutter breaks up the peat, which is then pumped to the disposal area behind the embankments. While dredging has been proceeding, the coal preparation plant and ancillary installations have been under construction. Because of the varying coal qualities in the seams to be worked, two large storage bunkers, each capable of holding 13,000 tons of coal, have been built ; these will enable the raw coal to be blended in suitable proportions before passing to the washing plant. The blended raw coal, without passing through the washery, will also be supplied to the Scottish Gas Board's Lurgi gasification plant to be built nearby.

Coal required for acceptance tests for the coal preparation plant will be won from an area in the north of the site adjacent to an area worked over ten years ago. When Westfield goes into production the first portion to be worked will be in the south, in the area now being dredged. Development of this area will therefore await completion of the dredging and the dewatering of the area.

Dredger at work on the artificial lake. Dredged material is pumped to storage embankments through a floating pipeline

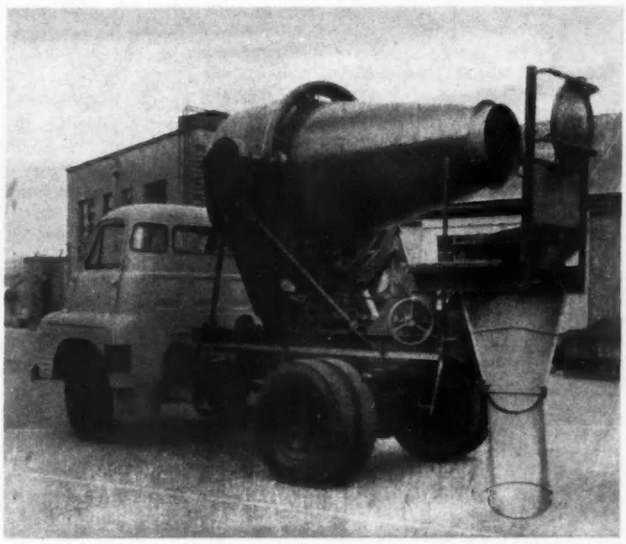
Truck-Mounted Concrete Machines

A RECENT addition to the concrete mixing and handling plant made by Ransomes and Rapier, Ltd., of Ipswich, is the truck-mounted 3 cubic yard capacity agitator illustrated on this page. The whole of this agitator equipment is mounted on a welded steel main frame so that it can be fitted to any make of truck of suitable capacity and driven from its engine power take-off.

The drum of the agitator is of steel plate and is fitted with internal spiral blades designed to move the concrete longitudinally, and this movement, combined with the drum rotation, prevents segregation of the mix. A heavy gear ring through which the drum is rotated incorporates a path for the supporting rollers which are mounted on ball bearings. The drum rotates and pivots in a box section welded steel cradle, guide rollers mounted on ball bearings being fitted to maintain the drum in position whilst leaving it free to rotate. At the bottom of the cradle there is attached a quadrant through which the drum is tilted up to 50 deg. above horizontal when fully elevated for loading or to 15 deg. below horizontal for discharge. Either hand or power-operated means can be provided for tilting the drum and, if required, both can be fitted together with an interlocking and selecting mechanism. Tilting is effected through a chain attached to the cradle quadrant and driven by a sprocket from a gearbox. A brake is automatically applied to hold the drum at any angle to which it is tilted.

For drum rotation, drive from the engine power take-off is transmitted to the spur wheel in mesh with the main gear ring on the drum through a series of gear reduction units which are coupled together by Hardy Spicer shafts. Synchromesh changes are, clearly, inadmissible when the drum is in gear : all changes would be virtually clutchless. The shafts serve to accommodate deflections between the agitator frame and the chassis whilst the vehicle is running. All of the bearings and gearing for the drum tilting and rotating equipment are totally enclosed to ensure adequate protection against the dust which is necessarily prevalent under the conditions in which the machine works.

A hinged operator's platform at the rear of the machine enables the self-sealing drum lid to be easily removed, and below it there is situated a fixed hopper. This hopper guides the concrete into a swivelling chute, with a hinged outer section, which can be moved through a horizontal arc of 180 deg. to place the mix. The rate of concrete discharge is controlled at all times by varying the speed of the drum and its angle.



3-cubic-yard, truck-mounted, tilting agitator

In our issue of November 7, 1952, we gave some notes on one of the firm's 4½ cubic yard lorry-mounted horizontal drum concrete mixers; it is now also making a high-discharge, lorry mounted machine of 3½ cubic yards mixing capacity. In this new high discharge mixer the drum is set at an angle of 15 deg. to the horizontal and is driven by a separate Ford diesel engine. The drum is located at the front end by a steel trunnion and supported at the discharge end by two rollers running on steel paths welded to its circumference. Two drum speeds are available through a two-speed gearbox—13 r.p.m. for loading and discharging concrete, and 3 r.p.m. when the machine is used as an agitator.

Two continuous spiral blades in the drum give a double end-to-end mixing action, and concrete is discharged by reversing the direction of drum rotation. The rate of flow when discharging concrete is controlled by varying the speed of the drum. The concrete is delivered via a fixed chute to a swivelling chute, which can be swung through a horizontal arc of 180 deg., with a steep angle of discharge. A water tank of 100 gallons capacity is situated over the engine at the front end of the drum and from it a predetermined weight or volume of mixing water can be delivered into the discharge end of the drum when the machine is being used as an agitator, or through the trunnion at the base end when it is being used as a mixer. When the machine is being used as an agitator it has a capacity of 4¼ cubic yards.

Industrial and Labour Notes

Economic Expansion

In the House of Commons on Monday and Tuesday, the debate on the address in reply to the Queen's Speech dealt with economic affairs. An opposition amendment, proposed by Mr. Harold Wilson, noted "with concern" that Government policies had led to "a fall in industrial production, a continuing increase in unemployment and a failure to make full use of our industrial capacity."

The Chancellor of the Exchequer, Mr. Heathcoat Amory, spoke on Monday. During his speech, he said that by the end of this year the rate of public investment would probably be running appreciably above that of last year, which was estimated to have been about £1425 million. For next year, 1959–60, a level of public sector investment about £125–£150 million higher than that of last year was envisaged. That should be sufficient to offset any fall that was at all probable in private fixed investment. The increased expenditure, by itself, the Chancellor added, was the equivalent of jobs for up to 150,000 workers in the two-year period.

The Chancellor went on to say that, in laying out this increase in the public sector investment, the plans had been based on the expectation of a resumption in economic expansion and its continuation over the next few years. Some people, he knew, detected signs that the present record level of private industrial investment might not be maintained next year, but he himself was impressed by the resilience it had shown so far. When the level of production turned upward, the Chancellor continued, he expected that it would "usher in a further period of expansion of every part of our economic life." For public sector investment that had two consequences: first, it meant that the task must be to ensure that enough resources were devoted to what might be called the productive public investment needed to support expansion, as, for example, electric power, railways and roads. Provision was, therefore, being made for a "very considerable investment" under those heads, a large increase over last year, both in absolute and in percentage terms. In other areas of public investment, the big programmes in the non-industrial sphere—schools, technical colleges, universities—were continuing to unfold. The expenditure on hospital development continued to increase and increasing investment was likewise expected in water supplies and sewerage works and in quite a wide range of other services. But, secondly, the Chancellor remarked, we must be aware of the danger of making a mistake which had been made before, which was embarking upon expansions of public investment without fully weighing the likelihood that by the time the programmes came to fruition they might be overloading the economy.

Employment and Unemployment

During the House of Commons debate referred to in the preceding note, the Minister of Labour, Mr. Iain Macleod, reviewed the employment situation. He said that, since July, there had been a slackening off in the upward trend in unemployment as compared with the earlier months of this year. But, the Minister added, it was very difficult and perhaps rather rash to try to forecast the future. Unemployment was bound to go somewhat higher in the winter months; it did so every year, as the opportunities for employment, for example, in the tourist trade, agriculture, fishing, building and in other occupations declined with the shorter working days and with the more difficult out-of-door working conditions. Therefore, the month from September to October was, even in a normal year, a month that showed a substantial increase in unemployment. This year had been no exception. The figures showed a more than usual seasonal increase, the unemployment percentage in Great Britain having risen from 2·2 to 2·3 and the number of people unemployed to 514,000.

The Minister went on to say that he expected the seasonal peak of unemployment next year to be in January and in February. He was quite confident, however, that there would not be any catastrophic decline in the level of employment or a great increase in the number of those unemployed. The January figures, of course, always reflected the seasonal slackness that followed from the Christmas trade and almost every year January showed the largest increase in unemployment. Taking that into account, and even assuming that the figures for the next few months would be rather worse than the normal seasonal decline, the Minister thought that the unemployment figure would not be as much as 3 per cent in the early months of next year. After that, it could be hoped that seasonal factors, accelerated by the results flowing from the vigorous action the Government had taken and was taking, should produce a welcome improvement.

Shipbuilding Statistics

According to statistics issued by the Shipbuilding Conference, the orders received in the year ended September 30 amounted to 167 ships of 638,684 tons gross and compare with the total of 350 ships of 2,708,147 tons gross contracted for during the twelve months ended September, 1957. The figures relating to cancellations of contracts for the two periods were thirty-seven ships of 405,560 tons gross and nineteen ships of 77,693 tons gross, respectively. With regard to the overall position of the industry, the total order book at the end of September stood at 670 ships of 5,953,000 tons, with an estimated value of £860 million; the comparative figures on the same date one year ago were 848 ships of 6,971,000 tons gross.

Iron and Steel

Questions were asked in Parliament on Monday about the "continuing recession" in the iron and steel industry. In reply to them, the Parliamentary Secretary to the Ministry of Power, Sir Ian Horobin, said that the decline in steel production had largely been brought about by the sharp fall in export demand and by the running-down of stocks. To secure the reversal of that trend was part of the Government's general economic policy. Sir Ian was then asked if the recession in the steel industry would make any difference to the industry's long-term expansion plans and whether it would not be a useful function for the Iron and Steel Board to prepare a special report on the matter. To that he replied that, while the Government must bear short-term recessions in mind, these should not in themselves be a ground for altering, without close consideration, long-term and carefully worked-out plans.

The Joint Iron Council

The report of the executive committee of the Joint Iron Council, for the year ended June 30 last, which was presented at the Council's annual meeting on Tuesday, comments on the present "somewhat sombre setting" of the ironfounding industry. The report points out that, since 1955, overall industrial production has been virtually unchanged. This period of stagnation has followed that from 1949 to 1955, when production was rising at an average rate of approximately 4½ per cent per annum. These fundamental facts, the report says, are behind the trading difficulties which have increasingly beset the iron industry during the past year. Many of the great industries which constitute some of the iron industry's most important customers, after investing in much new plant, find themselves with surplus capacity. Consequently, their demand for new equipment embodying cast iron has dropped steeply.

The report was prepared, of course, before the Chancellor of the Exchequer made his speech in Parliament last Monday. It, therefore, contains an observation that "in the absence of some more positive stimulus such as increased expenditure on major capital projects or a resumption of foreign lending on a sufficiently large scale, neither the ironfounders nor the pig iron producers can expect an early improvement in their fortunes." But the report expresses the confident belief that the future of the iron industry is fundamentally sound and that its present difficulties should be accepted as part of the price of achieving a degree of stability in the nation's economy which has been sadly lacking in the years that have passed.

Following the annual meeting, the Joint Iron Council's banquet took place on Tuesday evening at the Dorchester Hotel, with the president, Mr. N. P. Newman, in the chair. A toast to "The Iron Industry" was proposed by Sir John Maud, who until recently was Permanent Secretary to the Ministry of Power. The toast was acknowledged by the president, Mr. Newman, who said that the activity and prosperity of the ironfounding industry depended to a large extent upon capital investment. The measures announced by the Government would, he thought, "do something but not enough." He felt, therefore, that the Government must be urged to do more in the way of capital investment projects. Sir Brian Robertson, chairman of the British Transport Commission, also spoke. He claimed that iron, coal and railways were the three essential ingredients from which the industrial prosperity of England had been compounded. The three industries, Sir Brian said, were complementary; they were immensely important to each other to-day and were likely to remain so in spite of many new inventions and practices.

Friction of Rubber

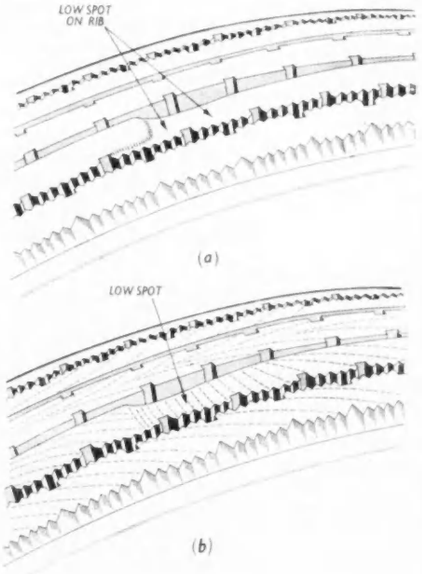
By V. E. GOUGH*

No. II—(*Concluded from page 704, October 31*)

There was presented to the "1958 Rubber Conference," organised by the Deutsche Kautschuk-Gesellschaft, and held at the Gürzenich in Cologne, a treatment of the fundamentals of friction. Substantial portions of the paper we reproduce : the full text will appear in "Kautschuk und Gummi." Slow speed sliding friction tests of rubber on other surfaces show maximum friction during a slow movement or creep. A study of the movements of belts on pulleys during transmission of torque shows that the pulley surface speed is the same as the incoming belt, and this supports the hypothesis that the friction developed depends on the ratio of creep velocity to pulley speed. The behaviour of tyres during tractive and braking forces also exhibit similar phenomena. Under cornering conditions, speed has little effect on the tyre-ground frictional properties except in those cases where bodily slippage occurs. It is shown that this independence of speed supports the hypothesis proposed. Studies of force and movement distribution within the contact area show that movement occurs before the peak force is developed. Irregular wear of tyres is discussed and it is shown that a non-linear friction characteristic which depends on the ratio of creep to rolling velocity is in agreement with constant distances between patches of wear irregularity. The ratio of creep to rolling velocity can be considered to be related to the ratio of the times of contacting of the surfaces and the time during which two points, one in each surface, interact with each other.

Irregular Wear

IRREGULAR wear of tyre treads can arise whenever some local effect or accidental condition (such as localised braking due to a high place on the brake drum) produces a local place of high wear.[6, 26] The point of interest to the present discussion is that further patches of local wear subsequently develop spaced at approximately equal distance intervals from the original patch. This phenomena is in accord with the suggestion that the friction forces are functions of the ratio of creep to rolling velocities. This follows from the mathematical analysis of Appendix I. The constancy of wavelength in distance rather than in time explains why irregular wear is not speed dependent, and why it is difficult to eradicate once it has commenced. The low spot of the tread phases the slippage point and the point at which the cycle recommences, and the constancy in wavelength distance ensures that the distortion is built up to the critical value at the same place each time. The direction of buffing ridge patterns (Fig. 14)



(*a*) Local low spot.
(*b*) Buffing ridges on tyre as in (*a*).

Fig. 14—Buffing ridge patterns on an irregularly worn tyre: the direction of slip is at right angles to the ridge.

confirms that the tyre tread movements on the ground are different at the low spots and suggests the manner of distortion involved.[6, 26]

Equivalence of Ratio of Velocities and Ratio of Times as the Basic Variable

In the region where a tyre is in contact with the ground, the forward rolling velocity of the tyre has no more physical significance than that it is a measure of the time of contact of a given part of the tyre tread and the ground provided the tyre ground contact length is constant.

If v=creep or sliding velocity of tread
V=forward or rolling velocity of tyre

then with obvious terminology

$$\frac{v}{V}=\frac{l}{t}\cdot\frac{T}{L}=\frac{l}{L}\cdot\frac{T}{t}$$

where T is the time during which the tyre rolls a distance L and t is the time during which the rubber and ground slide or creep relative one to the other by a distance l.

In the cases where conditions make the contact length constant and if L is considered to be the length of contact, then T is the time of contact of any points of the surfaces during the rolling process. If l is the distance measured along the surface over which two particles, one in each body interact, then t is a time of operation of the frictional forces between those particles.

The factor l/L can be considered to be descriptive of the geometry of the contacting conditions including the microscopic or molecular features of the materials and is thus a constant for a given case or pair of bodies and thus could be incorporated in the friction constant for that case. This leads to T/t being the measure of the velocity conditions. T/t is the ratio of T the time of contacting of the surfaces during which molecular and other forces can operate in a normal direction to t the time during which shear forces across the interface can operate between a given pair of points or asperities or molecules, one in each of the two materials. This rearrangement enables a reconciliation of the sliding case with the rolling case. In the rolling case v/V is settled by the percentage slip or creep or by the slip angle. The ratio T/t is therefore settled by these conditions subject to the above discussion. The time T is automatically determined and also automatically tied to the time t by the conditions of the situation.

In the sliding case it is difficult to ascribe a meaning to the rolling velocity V but not so difficult to ascribe a meaning to the time of contacting of the two surfaces T, and it is thought that this suggests that the re-writing of the basic variable in terms of a ratio of times merits consideration.

Friction Laws

Although Bowden and Tabor's well-known work on friction[27] confines its reference to rubber in a brief summary of reference 1 and does not discuss any mechanism of rubber friction, Tabor has recently pointed out[28] that frictional resistance of rubber sliding on a rough surface consists of the sum of the force to shear the interface and the force corresponding to the work done in deforming the rubber over or past the asperities in the other surface. He further states that work done by an asperity which deforms the surface of the rubber could be estimated from calculations of work done during rolling of a sphere on rubber as dealt with in references 29 and 30. In certain circumstances this must be true, even when the forces are insufficient to tear chunks of rubber out of the tread surface as in Fig. 5 of reference 6, or to produce buffing ridges as in Fig. 3 of the same reference or those illustrating photographs in reference 31 and 26, which are even less coarse in character. An example of the consequence of damage due to such surface deformation as might be caused by sliding over asperities on the road is given in Fig. 2 of reference 6, where a blistering or porosity at 0·5mm below the surface was caused by locked wheel sliding on wet grass. The grass was coarse and rough.

That high shears exist just below the surface under Hertziam type loading can be deduced from theory and has been shown to operate in metals in rolling contact.[32]

The increased drag caused by this effect of roughness could not be of great magnitude even in the instance quoted, for the effective coefficient was known not to exceed 0·25 and may have been somewhat less than this. Similar drags could be expected from smooth surfaces under similar conditions of speed and wetness. Judging from fatigue test experience,[33] the fineness of the porosity developed in the rubber indicated that high temperature had been developed. This suggested that this particular example would correspond to a case where the effective drag developed by internal losses caused by the fluctuating deformations within the rubber as it passed over the rough surface was relatively large compared with average. Even so, its effect was not very important.

Furthermore, this manner of development of frictional resistance cannot be of primary importance otherwise it would not be possible to achieve the highest coefficients on smooth glass, higher than on emery.[1, 2] The facts suggest that asperities are most important in breaking through surface films and making real contact so that there are areas where the interface shearing involves molecular forces.

Turning now to the latter. These are dealt with for metallic and other crystalline bodies in references 27 and 34, the latter being a recent summary of the literature. However, these theories assume that a static friction is truly static and that the maximum is not preceded by a creep stage. On the other hand, Bartenev[35, 36] has developed a theory on the basis that the friction of rubber is a molecular-kinetic activation process which is governed by the structure of the rubber. This is found to explain that low-velocity creep occurs before the peak force is developed. The theory is developed on the basis that a molecular chain is in contact with the surface for a limited time and then moves to a new contact point, and under the action of tangential forces the direction of movement is disturbed from that of equal probability in any direction which occurs under zero tangential force. The mean speed of the displacement of the chains is taken as the speed of sliding. Schallamach's experimental work[37] appears to support Bartenev's analysis. Schallamach also deduces from the temperature dependence of friction that a rate process based on an activation mechanism is operating.

It would appear that this type of theory would provide the basis for an explanation of the phenomenon discussed in the present paper, if the influence of T, the time of contacting of the surfaces, could be introduced into the original assumptions. This would appear to correspond to the probable numbers of chains which had made contact with the interface since the beginning of the period of contact between the two bodies, thus allowing for the fact that the ends of the same molecular chains need not necessarily be assumed to be at the surface of the rubber all the time but are capable of kinetic

movement from within the bulk of the rubber and back again.

The present author has not developed the appropriate mathematical analysis, but it would appear that if, in Bartenev's equations, Nr, the number of chains in contact with the surface of a hard body, were to be expressed appropriately in terms of the frequency of movement of chain ends, to and from the surface, and the time of contact, then Bartenev's results would remain unchanged for long times of contact, but would depend on the ratio of creep and rolling velocities in the case of a rolling wheel which has a time of contact related to the conditions of rolling.

This would then give a theoretical framework in accord with the phenomena discussed.

Comparison With Friction of Metals

Although it is reasonable to expect rubber friction to depend on the molecular-kinetic properties of the rubber structure rather than that of the crystalline structure of metals, and so it is not unreasonable to expect rubber friction to exhibit phenomena different from that ascribed to those materials,[27, 34] it is interesting to note that the behaviour of wheeled bogies on electric trains requires the assumption that the "creepage" frictional force is proportional to that ratio of creep velocity to rolling velocity.[38, 42] There is adequate proof that the theories agree with practice and they, too, give vibration phenomena which have wavelengths constant in distance, not in time.

Theories of stresses between steel wheels and rails[39, 43, 44] assume a "clinging" or non-slipping zone at the entry changing to a slipping or creeping zone at exit. In view of the proved invalidity of that assumption in the section on belt drives, one is led to the suggestion made in reference 2, namely, that creep occurs before the maximum coefficient develops even in metals, but because of the high moduli it is difficult to detect.

Evidence that this may be true is contained in reference 49, where it is shown that, although the coefficient of friction between steel and indium decreases with speed of sliding above 10^{-2}cm per second, it increases with speed of sliding over the range from 10^{-10} to 10^{-6}cm per second. It is extremely low at the lowest speed quoted.

It is possible that ultimately work on the behaviour of rubber during frictional contact with other bodies may cause some revision of even the well-established theories of metallic friction.

Conclusions

It has been demonstrated by reference to a variety of examples drawn from practical cases that there are good reasons to believe that :

(*a*) Maximum frictional force between rubber-like materials and hard solids arises when there is some relative movement or creep.

(*b*) That the frictional force increases from zero to this maximum value with increase of movement or creep from zero to the value for maximum coefficient.

(*c*) That in the regions referred to in (*a*) and (*b*) either the ratio of creep or sliding velocity v/V or its equivalent, the ratio of time of contact to time of frictional interaction between two points, is a basic factor deciding the friction developed.

(*d*) It is possible that these effects can be explained in terms of rubber-like elasticity.

(*e*) At very high relative sliding velocities where v/V is near unity, then the friction becomes velocity dependent as it is largely a matter of surface film breakdown or removal.

These findings are of fundamental importance in explaining the observed behaviour of tyres and other mechanical products in frictional contact with other materials and, in particular, why those tyre properties which depend on the development of frictional force with limited slippage at the ground are more or less independent of speed over a very wide range.

Acknowledgments

Acknowledgment is made to the Dunlop Rubber Company for permission to publish this paper.

The author wishes also to thank many colleagues who have helped to develop the ideas expressed in this paper, in carrying out investigations and in discussion of the results.

Particular thanks are due to Dr. Hofferberth, who invited me to write this paper and who very kindly translated it into German.

APPENDIX

Relaxation Oscillations when Friction is a Function of a Ratio of Velocities

The objective of this appendix is to show that if the frictional resistance has a characteristic of Fig. 7, that is, the friction increases to a maximum and then decreases to a constant value when plotted against increasing values of ratio of creep velocity to rolling velocity, then a relaxation oscillation which is constant in distance (not in time) results.

While those results which are obtainable by reference to standard text-books on non-linear oscillations[45, 46] will be assumed, some brief background is given to make the subsequent analysis clear.

Any motion can be completely described by its trajectory on a phase-plane which has velocity $\dot{y}$ and displacement y as its co-ordinates. If the phase plane trajectory is a closed loop the motion is periodic as the body returns repeatedly to the same point with the same velocity.

The periodic time is given by

$$t=\oint\frac{dy}{\dot{y}}$$

where $\oint$ indicates integration around the loop contour.

An ellipse or a circle corresponds to simple harmonic motion ; any other closed loop corresponds to a non-linear oscillation of some kind. If the damping in a system is positive in character throughout the whole velocity range then, in the absence of a driving force, the curve will spiral inwards towards the origin. If the damping is negative it will spiral outwards and the magnitude of the oscillation will increase indefinitely.

If a system has a negative damping characteristic over a sufficient portion of its velocity range, self-sustained oscillations of the relaxation type are possible and these correspond to closed loops on the phase plane.

To simplify the drawing of the phase plane trajectories in the case of linear spring, non-linear damping systems, Lienard proposed the following graphical construction[46] (Fig. 15).

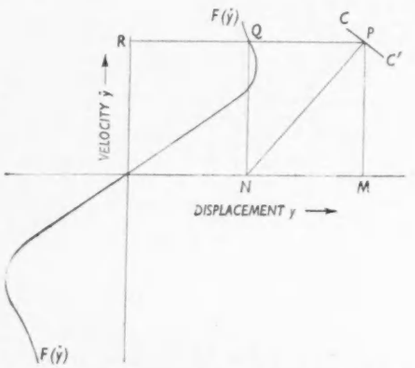


Fig. 15—Lienard's graphical construction for linear springs, non-linear damping

The equation (written in its simplest form assuming mass and spring stiffness are both unity)

$$\frac{d^2y}{dt^2}-F(\dot{y})+y=0$$

is rewritten as,

$$\frac{d\dot{y}}{dy}=\frac{F(\dot{y})-y}{\dot{y}}$$

by replacing $\frac{d^2y}{dt^2}$ by $\dot{y}\frac{d\dot{y}}{dy}$ which are equivalent.

The friction curve $F(\dot{y})$ is drawn along the $\dot{y}$ axis with the $F(\dot{y})$ values measured in the y direction. Assume the initial point is 0 where y and $\dot{y}$ are y_0 and $\dot{y}_0$. Draw PR parallel to the y axis, and PM and QN parallel to the $\dot{y}$ axis.

Because $PR=y$ and $PM=\dot{y}$

$$\frac{-NM}{PM}=\frac{F(\dot{y})-y}{\dot{y}}$$

and so NP must be perpendicular to the phase plane plot CC' passing through P.

It is possible to complete the loop by a step-by-step process. In the case where a surface rubs across another with a velocity u and the relative rubbing speed is $(u-\dot{y})$ the diagrams can be obtained by moving the $F(\dot{y})$ curve along the $(\dot{y})$ axis by an amount u[47] (Fig. 16).

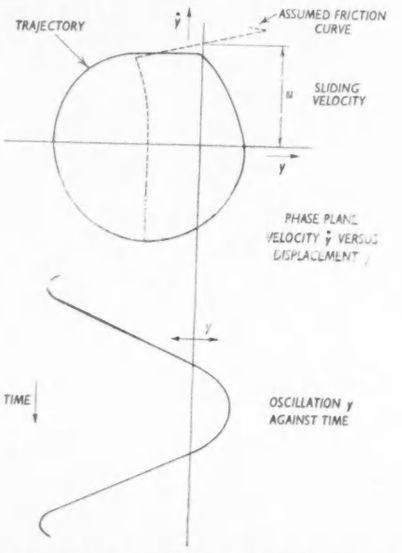


Fig. 16—Non-linear oscillation of elastically mounted body in rubbing contact with body moving at velocity u

The more general case of a non-linear damping together with a non-linear spring can be dealt with by a similar analysis. As pointed out by the present writer in a contribution to the discussion of reference 48, in this more general form of the analysis the slope of the phase plane contour at any point can be expressed solely in terms of the following physical quantities ; the visco-elastic reaction of the system, the applied driving force, and the momentum of the oscillating mass, thus enabling the dimensions to be studied as well as possessing other advantages.

If $f(y, \dot{y})$ is the visco-elastic reaction at any instant (i.e. spring and damping reactions together) and $G(t)$ the driving force at the same instant

$$m\ddot{y}+f(y, \dot{y})=G(t)$$

And as

$$\dot{y}=\frac{d\dot{y}}{dy}\dot{y}$$

$$\frac{d\dot{y}}{dy}=\frac{G(t)-f(y, \dot{y})}{m\dot{y}}$$

$$=\frac{\text{driving force}-\text{visco-elastic reaction}}{\text{momentum}}$$

$$=\frac{\text{force}}{\text{momentum}}=\frac{MLT^{-2}}{MLT^{-1}}$$

$$=T^{-1}\text{ or }\frac{1}{\text{time}}.$$

As can be seen from

$$\dot{y}=\frac{dy}{dt},\ dt=\frac{dy}{\dot{y}},\text{ and }t=\oint\frac{dy}{\dot{y}},$$

as stated earlier, and this latter corresponds to the oscillation time. In a case of a linear spring Ky and non-linear damping $-F(\dot{y})$ and no driving force, the equation reduces to

$$\frac{d\dot{y}}{dy}=\frac{F(\dot{y})-Ky}{m\dot{y}}.$$

Consider now a system with a linear spring Ky and a non-linear damping $g(\dot{y}/v)$ where $\dot{y}$ is the velocity of creep or slide and V the forward or rolling velocity which is assumed constant.

Let

$$\frac{\dot{y}}{V}=R\ ;$$

Plot the equivalent of a phase plane diagram with y and $\dot{R}$ as co-ordinates.

$$d\dot{R} = \frac{l}{V} d\dot{y}$$

Therefore

$$\frac{d\dot{R}}{dy} = \frac{l}{V}\frac{d\dot{y}}{dy} = \frac{-l\left(g(\dot{R}) + K\dot{y}\right)}{V\left(m\dot{y}\right)}$$

$$= \frac{\text{Force}}{\text{Velocity} - \text{momentum}}$$

$$= \frac{MLT^{-2}}{LT^{-1} \cdot MLT^{-1}} = \frac{l}{L}$$

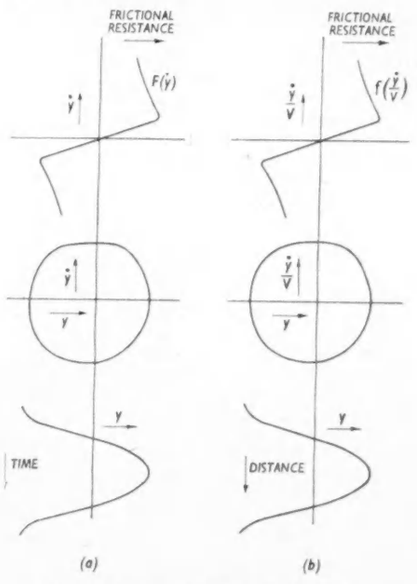
and

$$\oint \frac{dy}{\dot{R}} = \oint \frac{V dy}{\dot{y}} = \frac{LT^{-1} \cdot L}{LT^{-1}} = L$$

and which has the dimensions of a length.

The important point for our consideration is that the dimensions of the contour integral is " time " in the standard case where the damping is a function of the velocity $\dot{y}$, and " length " in the modified case where the damping is a function of the velocity ratio $\dot{y}/V$.

Hence, as can be seen from an inspection of Fig. 17, which compares two cases of bodies in



(*a*) Case where friction is function of velocity.
(*b*) Case where friction is function of y/v.

Fig. 17—Comparison of cases with damping a function of velocity and with damping a function of a ratio of velocities

sliding contact, one of which is elastically restrained and the other moves with a constant velocity V, when the damping is a non-linear function (with a negative slope in part of its range) of velocity of relative sliding, the vibrations have a constant periodic time, but when the damping is a function of the ratio of creep velocity to a rolling velocity V the vibrations have a constant periodic distance.

REFERENCES

[36] V. E. Gough and P. W. B. Jones, " Tyre Testing—Some Aspects in relation to Vehicle Behaviour," *Automobile Engineer*, January, 1952, Vol. 42, No. 549, page 17.
[37] F. P. Bowden and D. Tabor, " The Friction and Lubrication of Solids," Oxford, 1950.
[38] D. Tabor, Lecture at Rayon Research Institute, 1957.
[39] D. Tabor, " Elastic Work Involved in Rolling a Sphere on Another Surface," *British Journal of Applied Physics*, Vol. 6, March, 1955, page 79.
[40] D. Tabor, " Mechanism of Free Rolling Friction," *Lubrication Engineering*, November–December, 1956, *Journal of American Society of Lubrication Engineers*.
[41] A. Schallamach, " Abrasion Pattern on Rubber," *Trans. of the Institution of the Rubber Industry*, Vol. 28, No. 5, page 256.
[42] A. W. Crook, " Simulated Gear Tooth Contacts—Some Experiments upon their Lubrication and Subsurface Deformations," paper read November 16, 1956, to be published in *Proc. I.Mech.E.*
[43] V. E. Gough and D. Parkinson, " Dunlop Fatigue Test for Rubber Compounds, *Trans. of the Institute of the Rubber Industry*, December, 1941, XVII, page 168.
[44] J. W. Flaherty and S. Petach, Chapter 3, " Fundamental Aspects of Friction and Wear " (contributors N. B. Dewees and D. E. White) of *Corrosion and Wear Handbook for Watercooled Reactors*, edited by D. J. DePaul, McGraw Hill, 1957.
[45] G. M. Bartenev, " On the Theory of Dry Friction of Rubber," *Reports of the Academy of Science*, 1954, Vol. 96, No. 6, page 1161.
[46] G. M. Bartenev, " On the Discussion of Friction of Rubber," *Koll Zh*, 1957, Vol. 19, No. 3, page 397.
[47] A. Schallamach, " Velocity and Temperature Dependence of Rubber Friction," *Proc. of the Physical Society B*, Vol. LXVI, page 386, 1953.
[48] F. W. Carter, *Proc. Civil Engineers*, Vol. 201, Part I, page 248, 1916.
[49] F. W. Carter, " On the Action of a Locomotive Driving Wheel," *Proc. of the Royal Society A*, Vol. 112, 1926, page 151.
[50] F. W. Carter, " Stability of Running of Locomotives," *Proc. of the Royal Society A*, Vol. 121, 1928, page 585.
[51] B. S. Cain, *Vibration of Rail and Road Vehicles*, Pitman.
[52] Keller, *Mathematics of Modern Engineering*.
[53] L. Foppl, " Die Stronge Lösung für die rollende Reibung (The Rigorous Solution of Rolling Friction)," *Leibnitz-Verlag*, Munich, 1947.
[54] G. Heinrich, " Rolling Friction Theory of L. Foppl," *Ost. Ing. Arch.*, November, 1950, pages 363, 375.
[55] A. A. Andronow and C. E. Chaiken, *Theory of Oscillations*, Princeton University Press, 1949, from the Russian published in 1937.
[56] N. W. McLachlan, " Ordinary Non-Linear Differential Equations in Engineering and Physical Sciences," Oxford, 1950.
[57] B. R. Dudley and H. W. Swift, LXXVIII, " Frictional Relaxation Oscillations," *Philosophical Magazine*, page 849.
[58] R. E. D. Bishop, " On the Graphical Solution of Transient Vibration Problems," *Proc. I.Mech.E.*, 1954, Vol. 168, page 299.
[59] J. T. Burwell and E. Rabinowioz, *Journal of Applied Physics*, Vol. 24, February, 1953, page 136.

Lightweight Radio Compass

There was demonstrated in this country recently, during a conference of the Guild of Air Traffic Control Officers at Southend, a pre-production example of the sub-miniature radio compass for aircraft developed by Air-Equipement, of Asnieres, France. This performs automatically the function which used to be called radio direction-finding, i.e. it displays continuously the bearing of a transmitter. The operator is required only to tune in the receiver and identify the beacon by its call sign. The new equipment is believed to fall short in size and weight of all others, weighing 10½ lb.

The aerial unit is illustrated on this page. The loop has a ferrite core of ⊖ shape and is enclosed within a transparent plastics case

The transparent housing for the loop aerial facilitates setting up and inspecting. Notice the Hooke's joint in the pick-off transmission

about 1½in deep : the aerial bears a 360 deg. rose and the case has a cursor line engraved on it (there are actually two lines, one inside and one outside, so that parallax can be eliminated without reading both ends of the reference) and thus the indicator transmission can be checked readily. The aerial system includes compensation for quadrantal errors, i.e. errors originating from the electromagnetic influence of the aircraft. This is effected by including a Hooke's joint in the drive from the loop to the pick-off, and adjusting the angularity of the shafts until the departures from constant velocity of the joint cancel the quadrantal errors. If the aerial is mounted on the plane of symmetry of the aircraft, the error will be zero for a beacon bearing 0 deg. or 180 deg., and the drive is assembled with the coupling aligned on this assumption.

The receiver is only 4½in by 5½in by 6½in, and is expected to be small enough to be accommodated among the pilot's instruments. Subminiature valves are used in the radio- and intermediate-frequency stages and the automatic gain control : the audio-frequency stage, local oscillator, detector and servo amplifier are transistorised.

An interesting detail of the receiver is that the travel of the tuning handle, which makes many revolutions to traverse the scale, is not defined by stops on the variable condenser : instead, the first stage of gearing has a ratio very near to unity, and cams on the shafts are arranged to interfere at either end of the desired travel.

The indicator is marked off in 5 deg. divisions : 2½in or 3½in dials are available. The power unit uses a transistor oscillator and can operate direct from the 28V d.c. supply : it is protected against inversion of the supply.

We found the device simple to use on first acquaintance : its readings varied only sufficiently to show that the set was monitoring continuously. A " test " position on the selector drives the needle round the dial so that it can be checked whether the reading is repeatable.

The equipment is to be manufactured under licence by the Radar Division of Elliott Brothers (London), Ltd.

Lightweight Drainage Pump

A submersible 1000 g.p.m. drainage pump weighing no more than 39 kg is being put on the market by the Stockholm export firm, Svensak Motorborr. Being of very compact design and easily carried by one man, it is claimed to be a most handy tool for all kinds of construction work where water has to be coped with. It is said to be easily applicable in narrow and jammed working sites.

Designed and built by the Wedaverken, a Bofors subsidiary specialising in light alloy equipment, the pump is called the " Weda L3." The outer housing of corrosion-resistant " Hydronalium " alloy has a diameter of 270mm and a height of 470mm and is provided with double handles, which makes it easy to carry and place in position. The pump is driven by a built-in 5½ h.p., three-phase motor, completely protected from water by double sealing. It is cooled by the pump water and, when idling, by air blown through by the impeller. A temperature - sensitive switch automatically protects the motor from overheating if the pump, for instance, is sunk in deep mud.

This light pump is stated to pump out approximately 1000 litres per minute against a head of 5m, and against a head of 25m, about 250 litres per minute. For higher heads, two or more " Wedas " can easily be coupled in series by means of a special coupling device. Moreover, the pump is said to handle mud, sand and solid particles up to 5mm without difficulty.

Irkutsk Hydro-Electric Station

It is announced that the eighth and last turbo-generator of the 600MW Irkutsk Hydro-Electric Station, on the River Angara in Siberia, has gone into service.

The Irkutsk station is the easternmost hydro-power plant of the U.S.S.R. now in operation. It first went into service in December 1956.

Sixth International Congress on Large Dams

BY OUR AMERICAN EDITOR

No. II—(*Concluded from page 707, October 31*)

The International Commission on Large Dams, which is a body within the organisation of the World Power Conference, holds international congresses at intervals of three or four years. The fifth congress was held in Paris in 1955, *and was reviewed in* THE ENGINEER *of June* 10 *and June* 17, 1955. *Here, the sixth congress, which was held in New York this year, is reviewed. As customary, the principal technical work of the congress was divided into four "questions," at which the following subjects were explored :—heightening dams : stresses in dams and foundations ; comparing observations, computations and model tests : compaction and water content of earth and rock-fill dams : and the use of admixtures in concrete.*

IN the case of large arch dams it is extremely important to carry out every measurement from the very beginning and collect a sufficient number of measurements conscientiously performed with the aid of first-class measuring devices. Some authorities are of the opinion that the results of model tests are more reliable than those obtained by analytical methods, while others insist that the results need always to be compared with elaborate theoretical computations to arrive at a reasonably accurate solution. Model tests and analytical methods, having their advantages and disadvantages, should be such that they complement each other to a high degree. Comparison of the observed behaviour of dams with computations and tests on small models is essential for enhancing the value of the lengthy and error-prone work of observation. In spite of the many obstacles encountered in making any measurement on the prototype, the inaccuracies, differences and errors in construction induced by the measuring devices and instruments themselves, and in spite of the numerous difficulties involved in analytical computations and the large experiment stations and skilled engineers required to conduct model tests, it is invaluable that this comparison be made. Comparison alone will allow one to arrive at a final solution. Only in such a way, through a better understanding of actual behaviour will it be possible to achieve greater economy and safety of dams.

In this field, A. W. Simonds and J. T. Richardson, of the United States, presented an important paper comprising a review of observed structural performance of large concrete dams built by the U.S. Bureau of Reclamation. Of the studies of high concrete dams which have been constructed by the Bureau of Reclamation during the last three decades, the investigations concerning question 21 have been conducted in an exceedingly brilliant manner and are very extensive. This paper presents an overall view of these investigations and sums up the work as follows : " During the past three decades, the Bureau of Reclamation has studied the structural behaviour of the high concrete dams built under its jurisdiction. The dams that have been investigated are both gravity and arch type structures. The behaviour of the dams has been observed experimentally by means of instruments such as strain meters, stress meters, various types of pressure cells, and resistance thermometers embedded in the mass concrete of the dams. Where feasible, the movements of the dams have been determined also by means of plumblines extending in formed wells between the tops of the dams and their foundations, and by means of precise measurements of levelling and triangulation. Investigations of elastic and creep properties of concrete have been made and a method of computing stresses from strain measurements in mass concrete has been developed which includes the effect of creep. Examples of structural behaviour of two arch dams and two gravity dams as determined by observations on the structures are cited and the results shown on suitable diagrams. The arch dams include Hoover and Hungry Horse dams, and the gravity dams include Grand Coulee and Canyon Ferry dams. The behaviour of these dams, in general, has been studied to obtain a better understanding of stress, as derived from measured strain, within the mass of the structure and to determine the effects contributed to stress by the elements of progressing construction, loading of the dam during reservoir filling, contraction joint grouting, abutment grouting, and temperature variation, all of which result in the stress behaviour and structural performance during the service life of the dams. The analyses made from the data from strain meters embedded in the dams show progressively the stress conditions in the structure during these loading conditions. Model studies were made of two of the dams, namely, Hoover and Grand Coulee. The results of the model studies are shown on suitable diagrams for comparison with the results of the observations made on the structures. The conclusions drawn from these studies are : (1) that the stress distribution across sections between upstream face and downstream face does not follow a straight line and varies with temperature and load conditions ; (2) stresses caused by temperature changes in the mass concrete and by the construction programme may be greater than those produced by certain stages of reservoir load ; (3) the pattern of stress distribution does not stay constant, but with some variations follows annual cycles which are affected by temperature conditions and reservoir operations."

In the opinion of the reporter, the papers presented to the congress within the scope of question 21 have made important contributions towards solution of the numerous problems faced in constructing dams. The extent of the papers covers not only every type of dam, but also deals with observations, interpretations and mathematical analyses of these dams. Elaborate preliminary investigations followed by research during construction and operation of dams have yielded very useful data on the efficiency of the various solutions and proposed improvements. The progress made in development and extrapolation of the technical solutions is truly remarkable. The present available means of solution have become considerably more effective in both fields of research and construction than in the past, although the difficulties which have arisen are also very formidable. These papers will help to reduce the margin of ignorance, the so-called margin of safety, which has been so expensive to pay for and yet did not give assurance of a definite amount of protection. It is impossible, however, to attempt to formulate any universal doctrine from these results, and it is more appropriate to state the following individual results.

(1) When a small dam is built on solid rock, or on a dam site falling into a comparatively good classification, it may not be important to take great pains in geological investigations. Since good dam sites have recently begun to be scarce, there is a general tendency to build dams on foundations of less favourable conditions. Thus the study and progress of engineering techniques for improving the condition of foundation rock and soil have become of extreme consequence from the standpoint of safety and performance of dams. Incomplete survey may fail to detect geological accidents in the rock, or strata of more permeable materials of lesser stability. Theoretical and experimental studies, if not made with the maximum of care, will yield results that are quite different from those found during actual operation. On the other hand, detailed surveys and investigations will serve as guides for water-tightening operations or consolidation, and will provide means of controlling the execution of each phase of the work. In this manner, the work may be carried out with every guarantee of achieving satisfactory results and economy. One possible method of study is that of seismic geophysical explorations, which give the propagating velocity of vibration, thus providing mean values for wide scale survey of the elastic characteristics of the foundation. However, to be of practical value the results must be related to the modulus of elasticity for each given instant and to deformation due to consolidation of the rocky mass. If a correlation between the velocity of the elastic wave in the foundation and its bearing strength were clarified, it seems not only that the effectiveness and extent of grouting necessary could be determined, but also that a safe design of a dam could be made quickly and economically.

The reporter would like to propose a form for descriptively recording the results of geological features, especially in connection with engineering geology. It is desirable that geological structure, characteristics such as texture, facies, hardness, porosity of rock, degree of alteration, openings of joints and fissures, orientation, density, behaviour of faults and shuttered zones and the occurrence and disposition of seams are discussed. To translate the nature of the rock foundation into practical figures, observations *in situ* or in the laboratory are made of percolation coefficients, elastic moduli, plastic deformations, &c. These measurements may show pronounced differences under identical conditions according to the specific method of measurement used. It is therefore necessary to note the method of measurement in detail as well as to standardise them to some extent so as to be able in the future to compare the various means of observation. Therefore it is desirable that a symposium be conducted at an early occasion to study geological matters which should be noted and methods of measurement in relation to rock foundations especially concerning elasticity, plastic deformation, &c.

(2) Recently, it has become unavoidable to build dams in earthquake zones, and thus from the viewpoint of design and stability, it is of paramount importance to make clear the effects of earthquakes on dams. However, the observations *per se* of earthquakes are still quite inadequate, and although there are several cases where seismometers were installed in large dams there has been very little reported concerning results obtained. At present, actual dams are artificially vibrated by means of exciting machines to investigate natural periods and damping coefficients. These are studied together with the properties of seismic waves at the dam sites in an attempt to gain an understanding of the stability of the dams under earthquake conditions. Stresses occurring in a dam due to an earthquake may be estimated from the natural period and shape of vibration of a dam obtained by model tests. Considerable uncertainty is however embodied as the actual vibrations of a dam differ with vibrations of a model on a vibration table and the true conditions of foundation rock are difficult to reproduce in models. Earthquake failure tests by means of models are being attempted, but since the damping coefficient cannot easily be reproduced at present these must be augmented by analysis. In any case, in order to design a dam to be safe in an earthquake as well as being economical, observation, analysis and model testing must be developed in concert.

(3) In regard to the observations of dams, the following matters are some which appear to require special consideration, with a view to improving present knowledge, the economy of dams and development of new designs. It goes

without saying that the behaviour of a dam is influenced to a great extent by the construction work in the field. Therefore it is just as important to leave records of the field work performed according to specifications as it is to obtain records of observation on the completed dam. By doing so the relation between work specifications and dam behaviour may be made clear and will be of aid in improvement of designs and specifications for dams to be built in the future. In order to investigate the effects of hydrostatic pressure and thermal variations on dams it is considered very important to take more frequent or even continuous readings by using recording instruments. By doing so it would be possible to separate the individual effects of hydrostatic pressure, temperature variations, foundation displacements, &c., in a comparatively easy manner so as to know the behaviour of dams as regards the distribution of the stresses. It is important for the observation to continue through a long period, and for this purpose a proper organisation must be provided. The reporter believes that what the character of the organisation should be in order to put observed results to the most effective use constitutes one of the most important subjects of inquiry for the International Congress on Large Dams.

(4) Various theories have been advanced in calculating deformations and stresses. However, to the question of which stress, tensile, shear or compressive, is the determining factor in a failure, there seems to be no definite answer. This is because there are so many problems before engineers remaining to be solved. The present trend of evaluating the full action of structures until failure is most certainly commendable and should decidedly assure a better control of structural design. However, it seems impossible at present to design an arch dam on a basis of ultimate strength. The term "ultimate strength design" commonly indicates a design based on the ultimate strength of a cross section of a member. It does not deal with the evaluation of the external moments and forces that exist in structures. Maximum hydrostatic and thermal loads may be assumed to be unchanging during the life of a dam, but actual dynamic loads, as caused by earthquakes, are less predictable. Ultimate strength designs will permit the use of different load factors, which results in a more uniformly consistent factor of safety for dynamic loads and also may yield the load-carrying capacity of a dam, while by the elastic design method only the stresses produced by working loads are known.

An arch dam is a structure of much higher redundancy than an arch bridge. Yet though arch bridges are designed to-day by the ultimate strength method arch dams are not. This is a most disturbing matter. The design procedure may be very complex and difficult and the best solution may be achieved only after manifold trials, but this is a topic which certainly warrants investigation. The ultimate strength design is merely an extension of knowledge of structural action into the twilight zone between the limit of elastic range and ultimate failure. The question to-day is not whether the ultimate strength design of a dam would be sound, but rather to what extent it must be developed in detail and whether or not the dam engineer is ready to use it for the safety and economical construction of a dam. By model tests, it is possible to evaluate to a certain degree the load-carrying capacity of a dam subjected to hydrostatic pressure. In models, however, it is very difficult to reproduce the condition of movements caused by earthquakes of foundations and abutments in relation to movements of the actual dam. It is also a formidable task to find materials capable of holding similarity in damping coefficients with the dam. It becomes necessary to correct these deficiencies by analytical methods.

QUESTION 22

Question 22, "Compaction Methods and Moisture Content for Materials Used in the Construction of Earth Core and Supporting Fill for Earth and Rock-fill Dams," was reviewed by Dr. Ervin E. Nonveiller, of Yugoslavia. A total of twenty-two reports were submitted from thirteen countries, including four from the United Kingdom. The authors tackled their tasks in various ways. Some gave examples of executed dams with special reference to compaction, equipment used and results obtained. Others reported on the use of uncommon materials for embankments and their treatment on the job. Some reports referred to wet fills and others compared wet and dry fills. Rock-fill and its placing was considered in a few reports. Pore pressures recorded, their analysis and interconnection with placement moisture and methods were treated. In many reports laboratory test results were given and compared to compaction obtained in the field. Several reporters gave interesting descriptions of dam design with special reference to the utilisation of materials available from construction excavation, as well as descriptions of methods for handling materials which cannot be regarded as ordinary soils.

Reviewing the laboratory investigation of soil compaction, H. H. Dixon, of Great Britain, gave an example of a peculiar tropical soil in which over 20 per cent of the moisture determined by standard laboratory procedures was inert water contained within the voids of sponge-like aggregates and did not influence the mechanical properties of the soil. This example pointed out the necessity for comprehensive laboratory investigation, without which such hidden abnormal phenomena could not be detected. Such laboratory compaction tests reveal the qualitative and quantitative characteristics of various soils. Based on wide experience from observations on many executed dams come general rules for the application of laboratory results to the compaction in the field can be established, concerning the type and load of the roller, layer thickness, optimum moisture and dry density. Some problems, on the other hand, mainly dealing with the treatment of the material for drying, moistening, &c., can be solved only by means of full-scale tests in the field. Sometimes other soil characteristics are studied in full-scale tests, such as shear strength and its change with time and permeability consolidation. In these cases test embankments and test fields are of great value for the eventual selection of construction methods and specifications.

Soils used in the construction of earth-fill dams can be listed in four characteristic groups: sound rock; soft rock; gravel and sand without or with some silt and clay; clay, silty and predominantly clayey soils. For each of the above groups there are compaction procedures most adequate to their properties. Of course, there is some overlapping in cases of intermediate types of soils or according to the flexibility of use of each type of compaction equipment.

Many examples of construction of rock-fill dams have been published at previous congresses, and different procedures of placement and compaction of the rock-fill have been described. Hand labour aided by cranes for setting heavy stones was used in some Algerian dams and the rock-fill was built in a mason-like manner. Other dams were compacted in layers by the impact of heavy weights, by rollers or by vibrating slates without or with water sluicing. Another method consists of simply dumping the rock from the top elevation or in thick layers. This method was applied in San Gabriel dam No. 2 with only little sluicing. A heavy rain caused a sudden settlement of the nearly completed dam, amounting to some 12ft, which completely destroyed the upstream concrete facing. This method was used successfully on many dams combined with washing the fines into the voids by heavy jets.

The only restriction for the use of any soil for embankments and dams is given by the impossibility to compact it to a porosity at which further disintegration of particles, affecting the volume of the fill, becomes impossible. Soft rock which can be disintegrated and compacted to a sufficient low porosity may be applied for fills, especially in portions protected from weathering influences. For a long time now, experience has shown the importance of compacting earth-fills, and some kind of stamping, even by leading herds of cattle or sheep, was used in ancient dams. Many failures occurred on dams which were not compacted at all. Later on, this type of work became mechanised, and to-day we dispose of a wide range of compaction devices which do the work efficiently at a very low cost. Two characteristic types of soil in this group are: gravel and sand, on the one hand, and cohesive clayey soils on the other, with all transitionary varieties which occur in Nature. Smooth rollers are not the best tool for compacting gravel and sand placed in thick layers, because of the low shearing strength of the unloaded surface of such cohesionless fills. The rubber-tyred roller is more appropriate to do the work on account of the flexibility of its tyres which reduce the peaks of the surface loading to the amount of the inflation pressure.

The perusal of the reports concerning question No. 22 leaves the impression that the now already traditional sheepsfoot roller still plays a predominant part in the compaction of impervious embankments. Here and there new devices like the steel mesh cylinder, the segmented roller, the grid roller, &c., are mentioned, but no references on the performance of the new types on actual works have been reported and it is still not possible to give any conclusive opinion about their advantages and merits for the compaction of earth-fills in comparison to the sheepsfoot roller. In some instances the rubber-tyred roller has proved to be more efficient than the sheepsfoot roller, giving higher dry densities and better homogenisation of the compacted soil at fewer passes, thus increasing the output and probably the work economy. According to the U.S. Corps of Engineers construction specifications, either sheepsfoot rollers with 5 to 14 square inch foot area and 250 lb to 600 lb per square inch unit foot pressure, or heavy rubber-tyred rollers with wheel loads from 18,000 lb to 25,000 lb and 80 lb to 100 lb per squre inch inflation pressure, can be used for compaction of fills. In conclusion it can be stated that for every type of material there exist a distinct compaction method and a most suitable type of equipment. Owing to the multitude of possible variations of soil properties, laboratory and field tests will be necessary for the selection of the most appropriate compaction method and equipment for any specific case.

Placement Moisture Content

During a discussion at the Third Soil Mechanics Conference in Zurich, the predominant points of view of the "dry" and the "wet" placement schools were explained. This discussion was concluded rather in favour of the "dry" faction, but it seems that both of them have their justification and their field of application. This is really not a matter of principles but a matter of adaptation to many factors influencing the design and construction of earth dams. Deformability of the foundation, characteristics of the materials, climatic conditions, time schedule of works, &c., are all factors controlling the proper selection of placement moisture of the fill. It is a fact that a fill placed very dry will subside when saturated, and cause deformations which often are inconsistent with the scope of the dam. In construction practice there exists a limiting moisture content beyond which operation of equipment on the fill becomes impracticable. Hence, the placement moisture for every material is restricted on the dry side by the condition of non-settling at saturation, and on the wet side by the practicability of equipment operation on the fill. Between these two limits the proper moisture content must be selected under consideration of all factors influencing the purpose, stability and economy of the dam. In the proper selection of the placement moisture the meteorological conditions must also be considered. In dry regions water may be scanty and it is not possible to place the fill wet; on the other hand, in wet regions proper drying of the fill material may be impossible. In such cases the meteorological conditions control the proper selection of the placement moisture.

Field Placement Control

A rigorous field control is imperative on every dam construction to ensure compliance of the compacted fill with construction specifications. The first objective of field control on earth-fill dams is to ensure that the density and moisture are obtained with the lowest possible scattering from the values specified in the design, resulting in a homogeneous fill. On rock-fill dams the

control consists mainly of occasional checks of the grain size distribution and of the specified quantity of fines. For coarse-fill material this necessitates a full dumper load and tedious work, but with some checks the supervisory staff gets a feel for the right grading of the material and acquires the ability to estimate the percentage of fines by visual inspection of the loads, and to reject those containing more fines than specified. It is even more tedious and difficult to check the density of placed rock-fills. An alternative is to excavate fairly big holes in the placed fill for volume and weight determination. Another possibility is to determine the volume of a rock portion in the quarry and the resulting volume in the fill. It has become evident that the method of simply dumping and sluicing the rock-fill in high lifts yields substantially the same density as other more complicated and more expensive compaction methods. On the soft rock-fills the dry density and moisture content will mostly be checked on material excavated from holes, whose size depends on the size of the chunks contained in the fill. For gravel and sand fills the dry density and moisture content are commonly established by the water balloon or by sand replacement methods. For the control of earth-fills which do not contain coarse particles driven samplers are often used to extract soil samples for dry density and moisture determination. In such materials the Proctor needle may be useful to estimate the degree of compaction and the moisture range of the compacted lifts.

Pore Water Pressure

Different types of pore water pressure installations are mentioned in the reports, including simple standpipes, piezometer tips connected to Bourdon gauges and electro-acoustic manometers. The simple standpipe averages the hydraulic pressure over the immersed length of the pipe and can be of some use only in comparatively pervious materials where the slope of the phreatic line is low. In impervious soils a considerable time lag may cause distortions of the readings. Piezometer installations of the second type consist of porous tips connected by two plastic tubes to a measuring station housing the gauges and the de-airing device. The water pressure changes are recorded without volume change in the tubes thus avoiding time lags of the recorded values even in very impermeable soils. It has been observed that some migration of air exists from unsaturated fills into the tips and connecting tubes, and the entrapped air must be evacuated in advance of each reading. A different type of a pore pressure measuring device consists of pore pressure gauges which transmit electrically the pore pressures to the measuring station. Migration of air from unsaturated soil pores into the filter-plates protecting the sensitive membrane of the instruments has been observed also with this instrument. This rather small volume of air probably does not distort the results recorded because of the slow rate of change of pore pressures in dam cores. So far, experience with this type of installation has been satisfactory.

Settlement of Dams

For the selection of a suitable compaction method for rock-fill dams an analysis of the settlements during and after completion of such dams is important. Three types of settlement observation installations have been in use : the Swedish well, the telescoping pipes and the crossarm type of the U.S. Bureau of Reclamation. Equitable results from all these types are reported. For rock-fills the Swedish well is mostly used, although some objection can be raised against this observation device, since the individual rings will settle differently from the average fill if the surrounding fill is not properly compacted. In the Quioch rock-fill dam a Swedish well and telescoping pipes were installed. During the first year after completion the total settlement amounted to 0·04 per cent. The settlement of the Sarno dam was reported to be less than 0·07 per cent three years after completion. The dam consists of a silty gravel compacted in layers with sheepsfoot rollers.

The settlement of rock-fills is generally assumed to occur mostly during construction, the post-construction settlement being insignificant for practical considerations. The analysis of post-construction settlement discloses that rock-fill dams settle for a long time, probably as a consequence of subsequent failure of overloaded contact points and readjustment of internal stresses in the rock mass. A survey of the time settlement for some rock-fill dams indicates that the rate of post-construction settlement ranges between 0·01 and 0·04 per cent yearly ; the slope of the time settlement curve is nearly constant over a period of observation as long as forty-five years.

From all the information collected at the congress, it can be concluded that methods and equipment for compaction of materials for earth and rock-fill dams have reached the versatility necessary to suit the most variable kinds of soil and local conditions. More powerful and more efficient equipment will eventually come into service, like the recently introduced 100,000 lb heavy self-propelled sheepsfoot roller units, increasing the prospective rate of placing earth-fills. Based on laboratory and field testing methods as well as on field observation and experience, it is possible to establish the proper placing and compacting procedure, the equipment and the moisture content suitable for various kinds of soil, adverse climatic conditions and peculiar site conditions. Thus, designers have been given the tools necessary to conceive and produce safely and economically the most arduous artificial fills for water storage.

QUESTION 23

Question 23, " Use of Admixtures and Pozzolanic Materials in Concrete for Dams and the Influence of the Finer Sand Particles," was reported upon by Ing. Kristen Friis, of Norway, with the presentation to the meeting being made by Ing. Christian F. Groner. A total of twenty-eight reports were submitted from twelve countries, including four from Great Britain. The British contributions included an important paper on the " Use of Fly Ash at Lednock Dam," by R. H. MacDonald and A. C. Allen. It was decided to use fly ash in the Lednock dam* since sources were readily available, the demand on cement would be reduced, there would be technical advantages and a saving in cost. The source selected was the Braehead power station, 69 miles away by road. Braehead fly ash had previously been tested in concrete at Glasgow University and it was decided to adopt a 20 per cent replacement of it for cement. Further tests with the works mix and materials showed that the water-cement ratio of the previous ordinary Portland cement concrete used could be reduced by 0·04 and then the fly ash concrete gave 81 per cent of the previous concrete strength at twenty-eight days. After initial difficulties, tipping lorries transported the fly ash successfully by road and slight changes to a small cement plant enabled it to be used satisfactorily for storing and handling the fly ash on site. Initial control measures on site were to test the fly ash for carbon content by colour and for fineness by rubbing it between the fingers. Occasional samples were sent for full chemical analysis and specific surface determination. After the colour guide had been proved inadequate, carbon content was determined at the power station laboratory also.

The Lednock dam is believed to be the first major structure in the United Kingdom to have incorporated fly ash on a large scale. At the completion of the work, more than 82,000 cubic yards of fly ash concrete had been placed, resulting in a saving of 4 per cent of the cost of this volume of ordinary Portland cement concrete. The variability of the fly ash was far greater than expected, largely because Braehead, perhaps more so than any other British power station, due to its geographic location on the River Clyde, was compelled to use many different coals during the period it was supplying fly ash to Lednock dam. During 1956, 103 varieties of Scottish coal were used in addition to coal imported from the United States. The consequences of the variations were seen in the results of works test cubes. Investigations had shown that the strength of fly ash concrete decreased with increase in the carbon content of the fly ash and this is considered to be the reason for the average strengths of fly ash concrete works test cubes not giving the percentage that was expected after the Glasgow experiments. The carbon content of the fly ash used in these experiments was 1·8 per cent, much lower than the average carbon content of the fly ash used in the dam.

It was therefore not realistic to expect proportionate strengths of the same order as indicated by the Glasgow University experiments to be achieved on the works and, taking into account the greater variation of cube strengths about the mean, it is considered that a minimum required strength of 1800 lb per square inch would have been suited to the changed circumstances arising from the introduction of fly ash. It was decided, however, to have a required minimum strength of 2000 lb per square inch for the fly ash concrete at twenty-eight days, equal to 71 per cent of the minimum strength of 2800 lb per square inch specified for the Class F ordinary Portland cement concrete at the same age. This was considered the lowest twenty-eight-day strength of fly ash concrete which would develop at the end of one year at least the same strength as ordinary Portland cement concrete which had attained a twenty-eight-day cube strength of 2800 lb per square inch. In view of the low percentage of test cubes likely to fall below 2000 lb per square inch, no change was made in the concrete mix or the control measures and on only one occasion was this strength not attained. It is considered that the variations in the fly ash and their effects on concrete strengths justified the low fly ash replacement percentage of 20 per cent having been adopted.

The strength of fly ash concrete has been shown to vary with the carbon content of the fly ash, but it is not considered that this effect is due to the carbon content alone or that the magnitude of any strength changes would necessarily be the same when using one fly ash in combination with ordinary Portland cements of different chemical composition. As the carbon content in fly ash increased, so, generally, did the amounts of iron oxide and combined sulphuric acid, and there was less of the useful elements of silica and alumina. Also, the ash tended to become coarser to the feel. Whatever the extent by which each of these factors contributed to the strength changes, their combined effect was related to the carbon content.

Early determinations of the specific surfaces by the Lea and Nurse air permeameter of samples of fly ash taken from loads delivered to the site gave results which showed no relationship to the carbon contents of the samples or to the effects of the samples on concrete strength. Samples of high carbon content which were obviously coarse and " gritty " to the touch gave higher specific surfaces than finer samples of low carbon content. This effect has also been recorded in other investigations. It would be expected that efficient high-temperature combustion would produce ash having both finer particles and less unburnt carbon. Because of these findings, little importance was attached to the specific surface of the fly ash. The specific surfaces obtained for samples of Braehead fly ash were between 2000 and 3000 square centimetres per gramme and this range was considered to be generally applicable to all the fly ash received. Some specifications call for the specific surface of fly ash to be not less than 2800 or 3000 square centimetres per gramme but no difficulties were experienced with the Braehead fly ash arising from its specific surface being normally lower than these figures.

The present practice of expressing the "fineness " of fly ash used in concrete as specific surface in square centimetres per gramme is not considered satisfactory since it does not appear to bear any consistent relationship to any property of fly ash concrete. However, the size, shape and surface characteristics of fly ash particles are considered to affect workability and strength. The smaller the particles and, consequently, the greater their combined surface area, the more readily will chemical reaction and strength development take place.

Among the American contributions was an interesting account of an " Investigation of Pozzolanic and Other Materials to Replace Part of the Portland Cement in Mass Concrete Dams " by T. B. Kennedy of the U.S. Army Corps of Engineers. The Corps of Engineers has long

* The Engineer, July 18, 1958, page 84.

considered it to be highly desirable to reduce to a practicable minimum the amount of Portland cement in the concrete used in its dams. The primary reason for reduction of cement is economy. Close control of the particle shape and grading of the aggregates, improved equipment and methods of placement, and especially the use of air entrainment in improving the mechanical properties of lean mixtures have resulted in the regular and satisfactory use of cement contents of 2·25 to 2·50 bags (211 lb to 235 lb) of Portland cement per cubic yard in interior mass concrete. Further significant reductions will be difficult of achievement through similar improvements because 2·25 to 2·50 bags of cement are equal to about the minimum amount of sub-sieve material required to ensure placeability under field conditions. But further reductions in Portland cement itself can be achieved through partial replacement of the cement with other suitable finely divided materials with possible accompanying improvements in workability, strength, durability, impermeability, volume stability on cooling, and elimination of expansion caused by reaction between cement and aggregate. Such materials have long been known and used, but, prior to 1950, their selection and use on Corps of Engineers projects was based on local conditions applicable to individual projects. In 1950, the Chief of Engineers directed the U.S. Army Engineer Waterways Experiment Station to undertake a comprehensive investigation of all available classes of materials that might be used for partial replacement of Portland cement in mass and structural concrete. The purpose of the investigation was to obtain and study materials representing each class of commercially important finely divided materials that were considered suitable for use as partial replacements of Portland cement. Information was sought on the effects of such materials on the properties of concrete both before and after hardening in order to formulate specifications and test methods to ensure their quality and control their uniformity and to establish criteria for judging their suitability for use and estimation of optimum proportions in which they could be used.

Altogether, sixteen materials belonging to the following six classes were investigated :

Granulated water-quenched iron blast-furnace slag ; natural cement ; fly ash ; natural volcanic glasses ; calcined opaline shales ; uncalcined diatomite.

The chemical and physical properties of the materials were studied and the materials were used in air-entrained concrete with ¾in, 3in and 6in aggregate. Thirty-two large blocks were made with 3in and 6in coarse aggregate, from which cores were later drilled to test strength and permeability. Numerous laboratory tests were performed. The total amount of cement or blend of cement plus other material ranged from 1·75 bags per cubic yard (165 lb) to 4·0 bags (376 lb). A numerical system was devised for judging the performance of the materials based on bleeding (separation of water from the concrete on standing), permeability, strength and reduction of heat of hydration. The investigation showed that any of the materials investigated could be used successfully to replace a portion of the Portland cement to produce concrete acceptable for dam construction. Specifications for the procurement and testing of the materials have been established.

The following is a current representative specification "CRD-C 262-57" of the Corps of Engineers for pozzolan as an admixture for use in Portland cement concrete. Pozzolan is defined as a siliceous and aluminous material which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties. Two classes of pozzolan are covered by this specification :

Raw or calcined natural pozzolans (Class N).

The natural pozzolans include such materials as some diatomaceous earths, opaline cherts and chales, tuffs and volcanic ashes or pumicites any of which may or may not be processed by calcination ; and various materials requiring calcination such as some clays and shales.

Fly Ash (Class F).

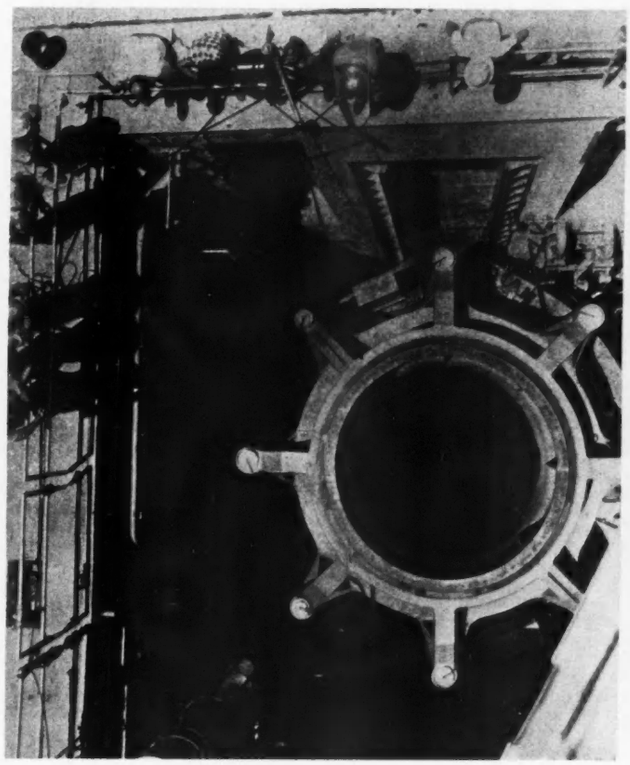
Fly ash is the finely divided residue that results from the combustion of ground or powdered coal and is transported from the combustion chamber by exhaust gases.

Pozzolan shall conform to the following chemical requirements :

	Class N.	Class F.
Silicon dioxide (SiO_2), plus aluminium oxide (Al_2O_3) plus iron oxide (Fe_2O_3), min (per cent)	70·0	70·0
Magnesium oxide (MgO) max (per cent)	5·0	5·0
Sulphur trioxide (SO_3), max (per cent)	4·0	4·0
Loss on ignition, max (per cent)	10·0	6·0
Moisture content, max (per cent)	3·0	3·0
Available alkalis, max (per cent)	1·5	1·5

Pozzolan shall conform to the following uniformity requirements. Results of the following tests on any individual sample shall not vary by more than the specific amounts from the average of similar tests on the ten preceding samples that comply with these specifications, or on all preceding samples if fewer than ten :

Fineness, specific surface, air-permeability test, max (per cent)	15
Specific gravity, max (per cent)	3



"Shaker" ship motion simulator for missile launching at Cape Canaveral, Florida

Pozzolan shall conform to the following physical requirements :

	Class N.	Class F.
Mean particle diameter, max (μ)	9·0	9·0
Amount retained when wet-sieved on No. 325 (44μ) sieve, max (per cent)	12·0	12·0
Pozzolanic strength of cement-pozzolan mortar at 28 days, min (per cent) of control*	75	75
Compressive strength of line-pozzolan mortar at seven days, min pound per square inch†	900	900
Increase in drying shrinkage of mortar bars at twenty-eight days, max (per cent)	0·03	0·03
Soundness, autoclave expansion, max (per cent)‡	0·50	0·50
Water requirement, max (per cent) of control	115	103
Reactivity with cement alkalis, reduction of mortar expansion at fourteen days, min (per cent)§	75	75

* 35 per cent pozzolan, 65 per cent cement by solid volume in 2in mortar cubes stored at 100 deg. Fah.

† Two parts pozzolan to one part lime by weight in 2in mortar cubes stored at 130 deg. Fah.

‡ The specimen shall remain firm and hard and show no signs of distortion, cracking, checking, pitting, or disintegration when subjected to the autoclave expansion test.

§ This requirement will apply only when so stated in the technical provisions of the contract specifications. It will only apply when the pozzolan is to be used with aggregate which is regarded as potentially deleteriously reactive with the alkalis in cement.

The pozzolan shall be stored in weathertight bins or silos at the source in such a manner as to permit easy access for proper inspection and identification of each shipment. Every facility shall be provided for representatives of the Government to perform careful sampling and inspection, both at the source and at the site.

The pozzolan may be rejected if it fails to meet any of the requirements of these specifications. Packages varying more than 5 per cent from the stated weight may be rejected. If the average weight of the packages in any shipment, as shown by weighing fifty packages taken at random, is more than 5 per cent less than that specified, or if the total weight of a bulk shipment is less than the stated weight by more than 5 per cent, the entire shipment may be rejected.

U.S. Navy Ship Motion Simulator

"SHAKER," the simulated shipboard installation on solid ground, has been completed by the Loewy-Hydropress Division, of the Baldwin-Lima-Hamilton Corporation, New York, who designed and built the 40ft tall sub-surface machine under contract with the U.S. Navy for its Fleet Ballistic Missile Programme. The large hydraulic rocking machine has come to life and moves up and down, fore, aft and athwart, under the electronic control of a distant operator in a thick-walled concrete block-house. The Navy's simulated ship has her "berth" on the Atlantic Missile Range at Cape Canaveral, Florida, not more than 800ft from the sea-shore. Sunk in a 47ft deep pit, she performs almost all possible movements of a sea-going vessel : sliding up and down she imitates the vertical heave motion, tilting left and right she acts out rolling, rocking forward and backward she pitches. An intricate mechanism of gyrating joints makes these various moves and their innumerable combinations possible. Sensitive people get sea-sick in merely looking at it. By proper setting, the actual behaviour of a sea-going vessel, from calm sea to the heaviest storm conditions, can be repeated and performed precisely by the moving "Shaker" platform. "Polaris," the Fleet Ballistic Missile of the U.S. Navy, will soon be tested on "Shaker."

Gas Turbine Evolution

MAJOR steps in the evolution of a practical and economic automotive gas turbine have been reported by A. L. Haynes, director of engineering research and advanced product study at the Research and Engineering Center of Ford Motor Company. The two major obstacles to be overcome had been the cost of turbines and the low performance of heat exchangers. The first had required a revolutionary change in fabricating methods : the turbine blades were assembled in their correct disposition and held by casting a low-melting-point alloy around the aerofoils. The billet for the disc was then hot forged to its final shape with the blades in place around it ; the metal extruded itself around the blade roots and the blades became parts of the wheel. A heat exchanger of 83 per cent effectiveness had been proven in service trials. With a power loading as heavy as 200 lb per horsepower gradients of 30 per cent had been climbed "with ease."

Personal and Business

Appointments

MR. G. RONALD GREEN has been appointed general sales manager of Tangyes, Ltd.

MR. J. N. TOOTHILL, Comp.I.E.E., has been appointed a director of Ferranti, Ltd.

MR. G. C. R. ELEY has been appointed a director of the British Oxygen Company, Ltd.

MR. B. HOMFRAY-DAVIES has been appointed managing director of Arusha Industries, Ltd.

HARLAND AND WOLFF, Ltd., has announced that Mr. J. H. Crossey has been appointed a director.

RUSTON AND HORNSBY, Ltd., has announced that Mr. R. A. S. Gimson has been appointed marine manager.

MR. J. A. GAY has been appointed patents exploitation officer to the United Kingdom Atomic Energy Authority in succession to Mr. T. Benson Gyles.

MR. B. F. LEVETT has been elected president of the Office Appliance and Business Equipment Trades Association for 1958–59 in succession to Major C. V. Wattenbach.

THE CENTRAL ELECTRICITY GENERATING BOARD announces the appointment of Mr. W. M. Tulip, M.I.Mech.E., as regional secretary of the North Eastern and Yorkshire Region.

B. O. MORRIS, Ltd., announces that Mr. J. H. Troman has been appointed a director of the machine tool division, Portsmouth. Mr. O. G. Eves has been appointed works director, Coventry, and Mr. L. Smith, a director of Bramble Engineering Company, Ltd., Coventry.

WOLF ELECTRIC TOOLS, Ltd., announces that the following members of the staff have been appointed directors of the company :—Mr. N. McCann, secretary and director ; Mr. R. G. J. Nisbett, director of Canadian operations ; Mr. J. A. Jackson, works director, and Mr. W. N. Scottorn, sales director.

MR. G. F. W. ADLER, A.M.I.Mech.E., has been appointed chief mechanical engineer and a member of the directorate of engineering of Marconi's Wireless Telegraph Company, Ltd., with responsibility for all mechanical engineering design aspects, both of Marconi's and its associated company, Scanners, Ltd.

THE MINISTRY OF HOUSING AND LOCAL GOVERNMENT has announced the names of five members of the Local Government Commission for England, which is to be set up shortly under the Local Government Act, 1958. They are : Sir Henry D. Hancock (chairman), Mr. Michael E. Rowe (deputy chairman), the Hon. Ruth Burton Buckley, Mr. Bernard D. Storey and Mr. E. W. Woodhead.

DOUGLAS FRASER AND SONS, Ltd., states that Mr. John G. Fraser, chairman, has relinquished his duties as sales director and has been succeeded in that capacity by Mr. John Macgregor. Mr. William Somerville has been elected to the board and takes over from Mr. Norman Fraser as works director. Mr. David H. Wallace, who recently retired as works manager of the engineering division, continues as a director and has accepted an appointment as works engineer.

Business Announcements

CROMPTON PARKINSON, Ltd., announces that Mr. J. Harwood Fryer has resigned from the board of directors.

AIRMEC, Ltd., High Wycombe, Bucks, has been appointed sole agent in the United Kingdom for the Microlambda Company, Italy.

FREDK. A. POWER AND SONS (Box Strapping), Ltd., Landor Street, Birmingham, 8, will in future be known as Power Strapping Systems, Ltd.

CHEVRON STRUCTURAL UNITS, Ltd., has moved to Cranmer House, 39, Brixton Road, London, S.W.9 (telephone, Reliance 3111).

INDUSTRIAL ASPHALTS COMPANY, Ltd., Adam House, 1, Fitzroy Square, London, W.1, states that its name has been changed to the Flintkote Company, Ltd.

MR. A. H. HIRD, M.I.Mech.E., has relinquished his seat on the board of directors of Vickers-Armstrongs (Engineers), Ltd., owing to his other commitments.

BLAW KNOX, Ltd., has announced the formation of a new affiliated company Blaw Knox Chemical Engineering Company, Ltd., 90–94, Brompton Road, London, S.W.3.

THE NELSON ENGINEERING COMPANY, Ltd., states that by mutual agreement the appointment of Veritys, Ltd., as the company's sales representative has now been terminated.

GRIFFIN AND GEORGE, Ltd., states that it is now connected to the Telex system at its Alperton Warehouse (Telex 21126), and Birmingham Warehouse and Works (Telex 33–033).

A.E.I.-JOHN THOMPSON NUCLEAR ENERGY COMPANY, Ltd., has moved from Crown House, Aldwych, W.C.2, to 33, Grosvenor Place, London, S.W.1 (telephone, Belgravia 7011).

MARTONAIR, Ltd., Parkshot, Richmond, Surrey, announces that it has appointed Vagnone and Boeri, Corso re Umberto 18, Turin, as its agent for Martonair pneumatic equipment in Italy.

BRITISH AVIATION SERVICES (ENGINEERING), Ltd., states that its buying office now operates from Silver City House, 62, Brompton Road, Kensington, London, S.W.3 (telephone, Kensington 4567).

THE INSTITUTION OF HIGHWAY ENGINEERS has announced the formation of its twelfth branch, the Southern, which covers Hampshire, West Sussex, part of Surrey, and the Isle of Wight. Mr. H. N. Jenner, M.I.C.E., has been installed as chairman.

NORTH DOWNS ENGINEERING COMPANY, Ltd., Westway, Caterham, Surrey, is now under new control. The following appointments have been made :—Mr. F. Hope, managing director ; Mr. C. F. N. Hope, technical director, and Mrs. M. T. Hope, director.

HOLLERITH (EAST AFRICA), Ltd., recently established, is the latest of six overseas subsidiary companies of the British Tabulating Machine Company, Ltd. It has taken over existing business in Kenya, Uganda, Tanganyika and Zanzibar, from Hollerith Machines (South Africa) (Proprietary), Ltd.

MR. L. C. W. TURNER has resigned his directorships with Brush Electrical Engineering Company, Ltd., and Brush Export (India), Ltd., members of the Hawker Siddeley Group, with effect from December 31, in order to take up an appointment as director and general manager of Aircraft Marine Products (Great Britain), Ltd.

MASSEY-FERGUSON (GREAT BRITAIN), Ltd., and LUNDELL (GREAT BRITAIN), Ltd., state that Lundell forage harvesters will be sold by Massey-Ferguson distributors and dealers throughout the world. At the same time, Lundell (Great Britain), Ltd., will continue to market these machines through its own distribution organisation.

JOHN CURRAN, Ltd., has transferred the whole of its engineering activities, covering the manufacture of aero-engine test equipment, radar and general engineering, to its main works at 15, Building Curran Road, Cardiff. The heavy installation, packaging and carpentry divisions remain at the Packing Depot, Cardiff (Pengam Moors).

TWIFLEX COUPLINGS, Ltd., The Green, Twickenham, Middlesex, has announced the conclusion of an agreement with Zahnaderfabrik Renk AB., Goginger Strasse 7—81, Augsburg (13B), Germany, whereby the Renk company has sole manufacturing rights for Twiflex automatic clutch couplings and flexible couplings for Germany.

THE BRITISH PETROLEUM COMPANY, Ltd., and SINCLAIR OIL CORPORATION announce that they have agreed in principle to develop a programme covering a long-term supply agreement covering Sinclair's U.S. domestic requirements for Middle East crudes produced by British Petroleum in the Persian Gulf area ; the establishment of a jointly owned company to engage primarily in the marketing of Middle East and Venezuelan crudes in the Western Hemisphere ; and the establishment of a jointly owned company to provide for exploration and production ventures primarily in Latin America.

Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., has been awarded a contract for the provision and installation of generating plant, together with switchgear, transformers and cabling, at the London County Council's Southern Outfall Works, Erith, Kent, at a cost of £658,962. The plant consists of ten generating sets each comprising a normally aspirated four-stroke-cycle, mechanically injected, pressure lubricated, seven-cylinder dual-fuel engine with a rated output of 1136 b.h.p., driving a revolving fired, salient pole, filter-ventilated alternator with an output of 800kW. The generators will supply electricity for the new works and will run on sewage gas produced from sludge digestion, supplemented by oil fuel. Heat will be recovered from the circulating water of the engines and from the exhaust gases to heat the digestion tanks. This work is under the direction of the Council's Chief Engineer, J. Rawlinson, M.I.C.E.

Miscellanea

CORRECTION.—A demountable artificial defect was described under the title "Inspection Techniques" on page 616, October 17 last. The breadths of the defects were given incorrectly : they are in fact 0·0001in, 0·0002in, 0·0003in, and 0·0004in.

DRIVING MECHANISM FOR SLUICE GATES.—In THE ENGINEER of May 30 last, page 822, a short article was published with the above heading, describing a new item of plant introduced by Flexible Drives (Gilmans), Ltd., for the power operation of sluice gates. We are informed that a new machine which has a far wider range of application has since been designed and made. The motor unit is mounted on a trolley, with a 6ft flexible drive to a reversible reduction gear head which is attached to the gate mechanism.

VERTICAL TAKE-OFF AND LANDING.—The Short S.C.1 research aircraft has made a flight free of all restraint. Both take-off, from the metal platform in which tethered trials have been conducted, and landing were vertical on the thrust of the four lifting engines ; between them the aircraft moved some distance in the forward direction. The aircraft is auto-stabilised in the jet lift mode, and the pilot's report indicates that controlling it is easy. The machine was illustrated on page 362, September 5 last.

LIQUID NATURAL GAS.—We are informed that the "Methane Pioneer," jointly owned by the Gas Council and Comstock International Methane, Ltd., has been converted to carry liquefied natural gas, and that after trials in the Gulf of Mexico will sail for the United Kingdom to deliver an experimental cargo to the North Thames Gas Board at its Canvey Island Terminal. Here the liquid natural gas will be converted to gas under pressure and delivered by pipeline to the Board's Romford works for reforming into town's gas.

CONCRETE PRODUCTS EXHIBITION.—The British Cast Concrete Federation in conjunction with the Cement and Concrete Association, has organised a photographic exhibition of concrete products. This exhibition of over 200 photographs will be on view in the Great Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1. It will be opened to the public at 2.30 p.m. on Tuesday, November 11 and from 10 a.m. until 6 p.m. on Wednesday, Thursday and Friday, November 12, 13 and 14. The exhibition will then go on a tour of a number of provincial cities during December and January.

TIMBER RESEARCH.—Following recent statements concerning its policy on forest products research, the Council for Scientific and Industrial Research recommends that the ultimate objective should be to concentrate all timber research at Princes Risborough, the site of the present Forest Products Research Laboratory. This, the council says, would avoid the danger of overlapping and unnecessary expense that might arise if separate laboratories were developed in different localities to serve the sectional interests of the timber trade and would ensure the most effective use being made of the qualified staff and material resources available in the various organisations concerned with timber research. Discussions are being held with the Timber Development Association and the Forestry Commission to determine the kind of organisation which would most effectively co-ordinate the research requirements of their interests.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The report of the Council of the North East Coast Institution of Engineers and Shipbuilders records that papers were read at twelve meetings and that the paper, "Service Performance Trials Carried Out in the North Atlantic on the S.S. 'Cairndhu,'" by S. L. Smith, D.Sc., and R. E. Clements, B.Sc., was awarded the Shipbuilding Gold Medal, while the Engineering Gold Medal was awarded to J. L. Jefferson, B.A., and R. C. Turner for their paper, "Tip Clearance and Shrouding Effects in Axial Flow Compressors." The paper, "Natural Circulation Investigations on an Experimental Two Tube Boiler," by A. M. Laird, B.Sc., Professor A. W. Scott, Ph.D., and Professor A. S. T. Thomson, D.Sc., Ph.D., was awarded the M. C. James Medal. Other awards include the triennial Gilbert Innes Prize to Mr. Kaare Haug and Mr. Norman Carter for their paper on the M.S. "Bergensfjord" and the biennial Amos Ayre Prize to Mr. R. E. Clements for his paper, "A Method of Analysing Voyage Data." The 1958 Doxford Scholarship and Prize and also the Weighton Medal, were awarded to Mr. Laurence Conway, while Mr. F. Taylor received the 1958 Swan, Hunter and Wigham Richardson Scholarship and Prize, and Mr. J. P. Jespersen was awarded the Thomas Fenwick Reed Medal.

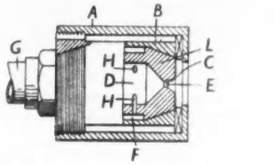
British Patent Specifications

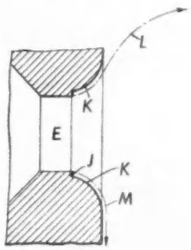
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

BURNERS AND SPRAYERS

802,087. January 11, 1956.—Fuel Atomiser, Power Jets (Research and Development), Ltd., 25, Green Street, London, W.1. (*Inventor: Harold Clare.*)

The invention relates to liquid fuel atomisers of the swirl atomising type. In such atomisers, atomisation tends to become poor at low fuel flows; it is an object of the invention to provide for improved atomisation under such conditions. As shown in the drawing, the atomiser comprises an outer casing or shroud *A* enclosing a cylindrical body made up of an outer tubular sleeve *B* and a central insert *C*. The insert is formed with an internal swirl chamber *D* tapering at one end to an axial discharge nozzle *E* in the end face of the body. The outer surface of the insert is recessed to form an annular gallery *F* to which fuel is supplied from pipe *G* through internal passages in the atomiser body. The gallery supplies fuel to the swirl chamber *D* through a number of tangential ports *H*, so that the fuel is swirled within the chamber and discharged through the nozzle *E* as a generally conical spray of atomised fuel. The



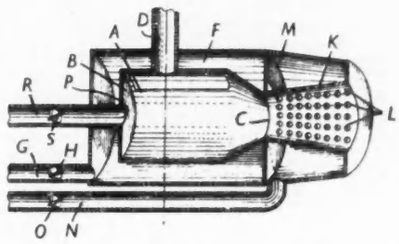


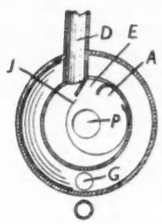
No. 802,087

nozzle *E* is cylindrical for part of its length and is formed with a small outwardly facing step *J* (shown in the lower view) close to the end face of the body *C*, and its edge is rounded off, the rounded off portion *K* extending from the base of the step to blend smoothly into the end face of the body. The step need only be quite small: for example, in an atomiser in which the nozzle diameter is 0·06in and the nozzle edge is rounded off to a quarter-circle of 0·03in radius, the step has a height of 0·002in to 0·003in. In normal operation, when the fuel flow is fairly high, the fuel is discharged in the normal manner from the edge of the step *J* as a generally conical atomised spray in the form of a "tulip" developing from a short neck at the nozzle, the envelope of the spray being indicated at *L*. It will be seen that the edge of the spray is clear of the rounded edge *K* of the nozzle, and the air flowing inwardly across the end face of the body tends to close up the spray so that it clears the edges of the opening in the end wall. As the fuel flow is decreased, poor atomisation normally tends to occur. In the arrangement shown, however, the neck of the "tulip" becomes shorter as the fuel flow is decreased until at some particular value of the fuel flow the spray is intercepted by the rounded edge *K*, whereupon the swirl and surface tension of the fuel cause it to flow outwardly around the edge and spread across the end face of the body *C*, as indicated at *M*. The fuel, having lost its axial velocity, is entrained and atomised by the turbulent vortex formed by the air flowing inwardly over the end face from the swirl plate, and it accordingly becomes possible to maintain atomisation at lower fuel flows than would otherwise be the case.—*October* 1, 1958.

802,246. July 29, 1955.—Oil Burner, Hoch-Temperatur-Technik G.m.b.H., formerly known as Debus-Maschinenbau G.m.b.H., Grosswelzheim, Unterfranken, Germany.

The invention relates to a burner for liquid fuels and more particularly but not exclusively to a burner for the complete and residue-free combustion of liquid or viscous fuels, particularly of such oils which consist of a mixture of multi-constituent oil components. As shown in the drawing, a distillation chamber *A* of cylindrical shape has an end wall *B*, while at its other end it opens into a comparatively large orifice *C*. The fuel oil enters the chamber by a pipe *D* adjacent to the inlet end of which an opening *E* is provided for the entrance of the air or other combustion-supporting gases. This opening is approximately tangential to the chamber *A* and is in direct communication with a jacket *F* which surrounds the chamber and into which the combustion supporting gas is admitted by a conduit *G* in which is a throttle valve *H*. The gas flows in an approximately tangential course into the chamber *A* and encircles the inner wall surface approximately in a spiral curve in the direction of the outlet opening *C*, while the





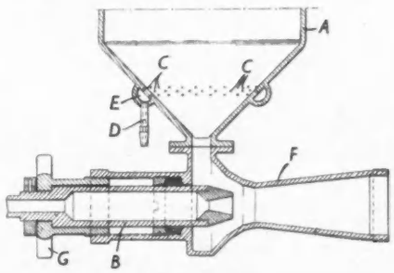
No. 802,246

opening *E*, seen in the spiral direction of gas flow, is behind the oil-admission opening *D*. The gas flow thereby causes the oil coming from the conduit *D* to spread on the surface in the shape of a film, which continuously advances helically in the direction indicated by the arrow *J* in the lower view. During this procedure the various components of the oil are distilled out so that with increasing temperature one constituent of the oil after the other evaporates and burns. The chamber *A*, forming the primary chamber of the system, opens into an outwardly flaring secondary chamber *K* in the conical wall of which are provided openings *L* for the admission of combustion-supporting gas. These openings *L* are in communication with a jacket *M* which surrounds the chamber *K* and into which combustion-supporting gas is admitted by a conduit *N* which has a regulating throttle valve *O*. Circulation of the combustion-supporting gas outside the chambers *A* and *K* has a cooling effect on the walls of these chambers, even if the admitted combustion-supporting gases are heated. It has been found advisable to provide an opening *P* in the end wall *B* to which a pipe *R* with a regulating device *S* is connected, and through which flame-increasing additional combustion-supporting gases or air may be blown into the combustion chamber. If desired, coal dust or the like may also be introduced through the pipe *R* for direct combustion in the chamber. As an alternative, the opening *P* may also be used for the introduction of articles to be heated.—*October* 1, 1958.

METALLURGY

802,711. August 27, 1956.—Introducing Finely Divided Solids into Liquid Metal, Paul Menzen, 43, Yorkstrasse, Bochum, Germany.

The invention relates to a device for introducing finely divided solids into molten metal. In it the finely divided solids pass by gravity from a container into a gas stream discharged under pressure from a



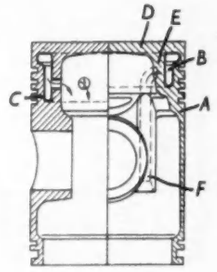
No. 802,711

nozzle. The device illustrated in the drawing consists essentially of a vertical container *A* with a nozzle *B* below constructed as a horizontal jet. Gas under pressure is passed through holes or slots *C* to the interior of the container from a connection *D* through an annular passage *E*. This gas effects the fluidisation of the finely divided solids so that they can flow without obstruction into an annular space surrounding the outlet of the nozzle *B*. Gas under pressure issuing from the nozzle entrains the solids from the annular space into a mixing tube *F* which supplies the mixture of solids and gas at a correspondingly high speed to the melt. By turning the ring *G*, the annular cross-section between the nozzle outlet and the mixing tube inlet mouth can be altered to vary the proportion of solids in the mixture as desired. A design with a vertical nozzle is also shown in the specification.—*October* 8, 1958.

INTERNAL COMBUSTION ENGINES

802,480. March 8, 1956.—Oil-Cooled Pistons, Karl Schmidt G.m.b.H., 10, Fabrikstrasse, Neckarsulm, Württemberg, Germany.

The invention relates to oil-cooled pistons for internal combustion engines. There are six drawings in this specification to show pistons having in the head, behind the ring-carrying part, cooling spaces of different constructions. In all figures, the cooling space consists of a thin metal sheet formed into an annular passage and introduced into the piston during the casting. A piston *A* for a two-stroke

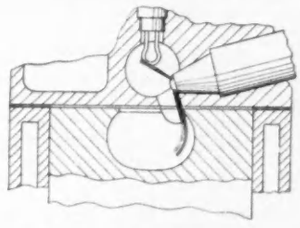


No. 802,480

diesel engine of the type illustrated in the accompanying drawing, has an annular cooling space *B* which is relatively narrow behind the ring-carrying part *C* and is in contact with the piston head surface *D* only over a small area. The ignition pressures are transmitted partly by way of the outer piston cross-section and, for the greater part, through the inner wall *E* of the cooling space *B* to the gudgeon pin sockets. The oil is fed through a cast-in jet tube *F*, which leads into the annular cooling chamber in such a manner that the oil reaches the hottest point. The axial length of the cooling chamber can be made so great, depending on the thermal loading, that either the entire annular part *D* or only a part undergoes direct cooling.—*October* 8, 1958.

802,118. February 7, 1957.—Injection Type Engines, The Daimler-Benz Aktiengesellschaft, of Stuttgart-Untertürkheim, Germany.

According to the invention, an injection type internal combustion engine has a main combustion chamber in the piston approximately symmetrical



No. 802,118

with respect to rotation about an axis extending longitudinally of the piston, and an ignition chamber in constant communication through a connecting channel with the main combustion chamber. The injection nozzle is adapted for injecting one jet into the ignition chamber and a second jet along the wall of the connecting channel into the main chamber. The construction and arrangement is such that the second jet, after passing along the connecting channel, enters the main combustion chamber substantially tangentially so as to impinge upon and be guided around the wall of the main combustion chamber as shown in the drawing.—*October* 1, 1958.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Nov. 7.—LIVERPOOL AND DISTRICT BRANCH: Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, 1, "Lubricating Oils and Greases and their Application to Industry," G. Stott, 7.30 p.m. ★ BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Bristol, "Electrostatic Precipitation," A. H. Thom, 8 p.m.

Mon., Nov. 10.—BOURNEMOUTH BRANCH: Grand Hotel, Firvale Road, Bournemouth, Hants, "The Industrial Uses of Magnetic Power," T. G. Hawker, 8 p.m. ★ CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, "Marine Electrical Installation," G. Hutchinson, 7.15 p.m. ★ NORTH WEST LONDON BRANCH: Century Hotel, Forty Avenue, Wembley Park, Middlesex, "The Approved Contractor and the National Inspection Council," E. J. Sutton, 8.15 p.m.

Tues., Nov. 11.—GLASGOW BRANCH: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Electric Pumps for Marine Uses," J. E. Bean, 8 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH: Offices of the Ministry of Labour and National Service, Lake Road, Portsmouth, "National Inspection Council for Electrical Installation Contracting," T. Howell, 7.30 p.m. ★ SOUTH-EAST LONDON BRANCH: Eltham Green School, Queenscroft Road, Eltham, London, S.E.9, "Stage Illumination," F. E. Brown, 7.45 p.m. ★ SOUTH WALES BRANCH: Angel Hotel, Cardiff, Open Meeting; Film of 1958 Electrical Engineers' Exhibition, 7.30 p.m. ★ YORK BRANCH: "Georgian House," Blossom Street, York, "Transistors," 7.30 p.m.

Wed., Nov. 12.—BIRMINGHAM BRANCH: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Press Photographer on Holiday," H. Crabtree, 7.30 p.m. ★ BRADFORD BRANCH: Midland Hotel, Bradford, "Motor Control Centres for Modern Industry," C. Robinson, 7.30 p.m. ★ LUTON BRANCH: Luton Chamber of Commerce, George Street West, Luton, "Quiz on I.E.E. Regulations," E. J. Sutton, 8 p.m.

Thurs., Nov. 13.—SOUTH WEST LONDON BRANCH: "Prince of Wales" Hotel, Wimbledon, London, S.W.19, "Thermo-Electric Cables," D. Redman, and "Air-Cooled Transformers," C. Penny, 7.45 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Nov. 12.—NORTH EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "The Use of Transistors in Communication and Control Equipment," E. Wolfendale, 6 p.m. ★ SOUTH WALES SECTION: College of Advanced Technology, Treforest, Glam, "Problems of Television Servicing," E. A. W. Spreadbury, 6.30 p.m. ★ WEST MIDLANDS SECTION: Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton, "Transistors in Television Receivers," B. R. Overton, 7.15 p.m.

CHEMICAL SOCIETY

Thurs., Nov. 13.—Lecture Theatre, Royal Institution, Albemarle Street, London, W.1, Centenary Lecture, "Inorganic, Organic and Technological Aspects of ^{15}N-Chemistry," K. Clusius, 7.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues. and Wed., Nov. 11 and 12.—Annual Conference at the Royal Hotel, Scarborough.

ILLUMINATING ENGINEERING SOCIETY

Mon., Nov. 10.—SHEFFIELD CENTRE: Grand Hotel, Sheffield, Presidential Address, C. C. Smith, 6.30 p.m.

Tues., Nov. 11.—LONDON CENTRE: Federation of British Industries, 21, Tothill Street, London, S.W.1, "Some Practical Considerations in the Design and Manufacture of Neon Signs," A. Urquhart, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Nov. 11.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Radio-Isotopes in Industry," W. G. Busbridge, 7.15 p.m.

Wed., Nov. 12.—DUNDEE BRANCH: Taypark Hotel, West Ferry, "Industrial Refrigeration," R. Campbell, 7.30 p.m. ★ EAST MIDLANDS BRANCH: Sherwood Room, County Hotel, Theatre Square, Nottingham, "The Foreseeable Future," E. S. Sellers, 7 p.m. ★ WESTERN BRANCH: Grand Hotel, Broad Street, Bristol, "Education in Industry," E. G. Sterland, 7.15 p.m.

Thurs., Nov. 13.—GLASGOW BRANCH: Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, "Packaged Oil-Fired Boilers," A. Wilson, 7.15 p.m. ★ NORTH-EAST BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "The Gas Turbine," H. R. Beaton, 7 p.m.

Fri., Nov. 14.—BIRMINGHAM BRANCH: Hotel Leofric, Coventry, "Maintenance of Automatic Plant," J. Ward, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

To-day, Nov. 7.—SOUTHERN JOINT BRANCH: College of Technology, Portsmouth, "A Review of Marine Steam Turbine Feed Cycles," A. D. Bonny, 7.30 p.m.

Mon., Nov. 10.—JUNIOR LECTURE: Willesden Technical College, London, N.W.10, "Modern Marine Steam Turbines," J. H. Gooch, 6 p.m. ★ MERSEYSIDE AND NORTH WESTERN SECTION: Stephenson Room, Engineers' Club, Albert Square, Manchester, 2, "Marine Machinery Breakdowns," J. H. Milton, 6.45 p.m. ★ WEST OF ENGLAND SECTION: Grand Hotel, Bristol, "Modern Marine Water-tube Boilers," A. P. Monk, 7.30 p.m.

Tues., Nov. 11.—Memorial Building, 76, Mark Lane, London, E.C.3, "The Design and Building of Icebreakers," A. Watson, 5.30 p.m. ★ Commemoration Service, conducted by the Reverend A. Powell Miller, 10.45 a.m.

Wed., Nov. 12.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Some Notes on Recent Reduction Gears for Propulsion Purposes," S. Archer, 7.30 p.m.

Thurs., Nov. 13.—MERSEYSIDE AND NORTH WESTERN SECTION: Technical College, Bolton, "Bent Tube Marine Boilers," E. G. Hutchings, 3.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, Nov. 7.—S. WALES CENTRE: S. Wales Institute of Engineers, Park Place, Cardiff, "The Free Piston Gasifyer with special reference to Vehicle Application," F. Wallace, 7 p.m.

Mon., Nov. 10.—E. REGIONAL CENTRE: Council Chamber, Houldsworth Hall, 90, Deansgate, Manchester, "Chassis and Engine Manufacture," R. P. Chilton, 7.45 p.m.

Tues., Nov. 11.—MIDLANDS CENTRE: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Research on the Testing and Performance of Commercial Vehicle Brakes," H. J. H. Starks, 7.30 p.m.

Wed., Nov. 12.—EAST MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Management and Personnel Control," A. J. Briscoe, 7.30 p.m. ★ SOUTHERN CENTRE: Royal Star Hotel, Maidstone, "Some Problems and Responsibilities of an Industrial Fleet Operator," R. H. Patman, 7.30 p.m. ★ WESTERN CENTRE: Royal Hotel, Bristol, "Rolls Royce Diesel Power," 7 p.m.

Thurs., Nov. 13.—SOUTH WESTERN CENTRE: Rougemont Hotel, Exeter, "Battery Manufacture and Maintenance," 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Nov. 10.—LONDON BRANCH: 6, Buckingham Gate, London, S.W.1, "The Design of a Power-Frame Tractor," H. E. Ashfield, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Nov. 11.—NORTH WESTERN BRANCH: Chemical Engineering Building, Manchester College of Science and Technology, Jackson Street, Manchester, "The Design and Operation of Refrigeration Plant in the Chemical Industry," D. M. Elliott, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 11.—Great George Street, Westminster, London, S.W.1, "Herdeka Bridge—Singapore: The Investigation, Design and Construction," R. J. Hollis Bee, 5.30 p.m.

Thurs., Nov. 13.—MIDLANDS ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "The Work of the Ordnance Survey," R. C. Gardiner-Hill, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Nov. 10.—INFORMAL MEETING: Savoy Place, London, W.C.2, "How Safe are Domestic Electrical Appliances?" opened by H. G. F. Gamble, 5.30 p.m. ★ N.E. CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "Investigations of Power-Follow Current Phenomena Using a Synthetic Power-Source," L. L. Alston and F. M. Bruce; "The Impulse Initiation of Arc Discharges," L. L. Alston, 6.15 p.m. ★ S. MIDLAND SUPPLY AND UTILIZATION GROUP: College of Technology, Birmingham, "Design and Application of Large Solid-Rotor Asynchronous Generators," P. Richardson, 6 p.m. ★ WESTERN CENTRE: S. Wales Institute of Engineers, Park Place, Cardiff, "Supply-Voltage and Current Variations Produced by a 60-ton, Three-Phase Electric Arc Furnace," B. C. Robinson and A. I. Winder, 6 p.m.

Tues., Nov. 11.—N.W. UTILIZATION GROUP: Engineers' Club, Albert Square, Manchester, Discussion on "To What Extent is Motor Protection Worth While?" opened by E. H. Nicholson and J. C. Jones, 6.15 p.m. ★ N. IRELAND CENTRE: Queen's University, Belfast, "Digging Up the Past," C. Snowdon, 6.30 p.m. ★ S.W. SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Recognition of Moving Vehicles by Electronic Means," T. S. Pick and A. Readman, 7 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, "A New Cathode-Ray Tube for Monochrome and Colour Television," D. Gabor, P. R. Stuart and P. G. Kalman, 6.30 p.m.

Wed., Nov. 12.—LONDON GRADUATES AND STUDENTS' SECTION: Visit to the Times Publishing Company, Ltd., Printing House Square, London, E.C.4, 3 p.m. ★ N.W. RADIO AND TELECOMMUNICATION GROUP: Engineers' Club, Albert Square, Manchester, "The Relation Between Picture Size, Viewing Distance and Picture Quality," L. C. Jesty, 6.45 p.m. ★ N. LANCASHIRE SUB-CENTRE: N.W. Electricity Board Demonstration Theatre, North Road, Lancaster, "Recent Developments in Medium-Voltage High-Breaking-Capacity Fuse Links," R. H. Dean, 7.15 p.m. ★ S. MIDLAND CENTRE: Victoria Technical Institute, Worcester, "The Influence of Maintenance Requirements on the Design of Industrial Electrical Equipment," H. C. Fox and J. H. Harris, 7.30 p.m. ★ SOUTHERN CENTRE: C.E.G.B. Offices, 111, High Street, Portsmouth, "A Survey of Harbour Approach Aids," A. L. D. Milwright, 6.30 p.m.

Thurs., Nov. 13.—UTILIZATION SECTION IN CONJUNCTION WITH THE BRITISH NUCLEAR ENERGY CONFERENCE: Savoy Place, London, W.C.2, "Electrification of the U.K.A.E.A. Industrial Group Factories," J. W. Binns and W. J. Outram, 5.30 p.m. ★ N. LANCASHIRE SUB-CENTRE: N.W. Electricity Board Demonstration Theatre, Duke Street, Barrow, "Recent Developments in Medium-Voltage High-Breaking-Capacity Fuse Links," R. H. Dean, 7.15 p.m. ★ N. SCOTLAND SUB-CENTRE: Queen's College, Dundee, "Results of Full-Scale Stability Tests on the British 132kV Grid System," F. Busemann and W. Casson, 7 p.m. ★ W. WALES (SWANSEA) SUB-CENTRE: S.W.E.B. Showrooms, The Kingsway, Swansea, "Earthing of Low and Medium-Voltage Distribution Systems and Equipment," F. Murhar, 6 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Nov. 7.—N.E. BRANCH: King's College, Newcastle upon Tyne, "Highway Law," C. W. Hurley, 7 p.m. ★ SCOTTISH BRANCH: Central Hotel, Glasgow, "Air Survey," W. A. Parkes.

Fri., Nov. 14.—LONDON BRANCH: Park Lane Hotel, Piccadilly, London, W.1, Annual General Meeting and Luncheon, 11.45 a.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Nov. 12.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Developments in the Detail Design of Diesel Locomotives," B. W. Anwell, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 7.—ORDINARY MEETING IN CONJUNCTION WITH THE INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Economic Design of Light Alloy Castings," P. A. Broadbent, 6 p.m.

Tues., Nov. 11.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "Fatigue Testing of Vehicle Components," T. C. F. Stott, 6 p.m. ★ SOUTH WALES BRANCH: Visit to Uskmouth Power Station, 3 p.m.; King's Head Hotel, Newport, Mon, "Failure of a 60MW Steam Turbine at Uskmouth Power Station," A. L. G. Lindley and F. H. S. Brown, 6 p.m.

Wed., Nov. 12.—EAST MIDLANDS BRANCH: Technical College, Lincoln, "Management Control of Small Engineering Firms," L. Fontaine, J. W. Walker and W. R. Spencer, 7.15 p.m. ★ YORKSHIRE BRANCH: The University, St. George's Square, Sheffield, "The World's Largest Walking Dragline," C. McL. Cameron, 6.30 p.m.

Thurs., Nov. 13.—HYDRAULICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Flow—the Origin and Nature of Turbulence: Boundary-layer Occurrences," 6 p.m. ★ NORTH WESTERN BRANCH: Engineers' Club, Albert Square, Manchester, "Test Bed Installations and Engine Test Equipment," by the late H. G. Freeston, 6.45 p.m. ★ LUTON A.D. CENTRE: Assembly Rooms, Town Hall, Luton, "Fatigue Testing in Vehicle Components," T. C. F. Stott, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: College of Art, Green Lane, Derby, "Some Investigations into Axial Compressor Blade Failure," J. Dunham, 7.15 p.m.

Fri., Nov. 14.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Experimental Investigation into the Effects of Cross Flow with Condensation of Steam and Steam-Gas Mixtures on a Vertical Tube," T. Furman and H. Hampson, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Nov. 10.—LEEDS SECTION: Hotel Metropole, Leeds, "Automation Tendencies in the U.S.A.," D. B. Foster, 7 p.m.

Tues., Nov. 11.—DONCASTER SECTION: Technical College Hall, Doncaster, "Current Developments in the Field of Spark-Machining," J. E. Winford, 7 p.m. ★ BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Engineering Application of Nylon," C. C. Morgan, 7 p.m.

Wed., Nov. 12.—HALIFAX AND HUDDERSFIELD GRADUATE SECTION: Visit to Samuel Fox and Co., Ltd., Stocksbridge Works, Near Sheffield, 6 p.m. ★ WOLVERHAMPTON SECTION: Technical College, Stafford, "Industrial Finishing Techniques and Practice (Paints and Organic Coatings)," J. J. Stordy and W. G. J. Appleton, 7.15 p.m. ★ LIVERPOOL SECTION: Exchange Hotel, Tithebarn Street, Liverpool, 2, "Management of Men," W. L. Kent, 7.30 p.m. ★ PRESTON SECTION: Municipal Technical College, Blakey Moor, Blackburn, "Work Study as an Aid to Management," W. H. Vale, 7.30 p.m. ★ LONDON GRADUATE SECTION: 10, Chesterfield Street, London, W.1, "Modern Industrial Relations," D. F. Hutchison, 7.15 p.m. ★ SOUTH ESSEX SECTION: Ilford Club, 21a, Balfour Road, Ilford, "The Application of Radio-Active Isotopes in Industry," J. L. Putman, 7.30 p.m. ★ EDINBURGH SECTION: North British Hotel, Princes Street, Edinburgh, "Industrial Applications of Oil Hydraulic Equipment," F. B. Levetus, 7.30 p.m.

Thurs., Nov. 13.—LEICESTER SECTION: Cromwell Room, Grand Hotel, Leicester, "Human Relations in Industry," J. Monro-Fraser, 7.15 p.m.

Fri., Nov. 14.—IPSWICH AND COLCHESTER SECTION: Golden Lion Hotel, Cornhill, Ipswich, "Joining Dissimilar Metals," A. A. Smith and J. G. Young, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Nov. 10.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Materials and Methods in Conveyor Belt Design," H. Green and K. E. Allison, 5 p.m.; "Dynamic Stiffness and Hysterisis of Rubber Compounds—the Results of Linear Analysis," D. H. Cooper, and "Non-Linearity in Dynamic Tests," V. E. Gough, 7 p.m. ★ SOUTH WALES AND MONMOUTHSHIRE SECTION: Wyndham Hotel, Bridgend, "Car and Motor Cycle Racing Tyres," D. M. Turner, 7.30 p.m.

Tues., Nov. 11.—LONDON SECTION: Royal Society of Tropical Medicine and Hygiene, Manson House, 26, Portland Place, London, W.1, "Rubber Products for the Motor Industry," C. H. Gregory, 5.30 p.m.; "Natural Rubber Compounds for High Temperature Service," S. G. Fogg, 7 p.m.

Wed., Nov. 12.—WEST OF ENGLAND SECTION: George Hotel, Trowbridge, "Anti-Ozonant Evaluation," K. R. Taylor, 7.45 p.m.

Fri., Nov. 14.—MERSEYSIDE SECTION: Adelphi Hotel, Liverpool, Joint Meeting with the Plastics Institute, "Some Activities of the Scientific Department, National Coal Board, Including Underground Trials on Conveyor Belts," J. G. Norvall, and "Laboratory Tests on Conveyor Belts and Their Correlation with Trials' Results," D. Bulgin, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Nov. 7.—MIDLAND COUNTIES BRANCH GRADUATES AND STUDENTS' SECTION: Exchange and Engineering Centre, Birmingham, "Advanced Ideas in Timber Structures," L. G. Booth, 6.30 p.m.

Mon., Nov. 10.—WALES AND MONMOUTHSHIRE BRANCH: Mackworth Hotel, Swansea, Chairman's Address, W. A. Evans, 6.30 p.m.

Tues., Nov. 11.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, "A History of Structural Engineering in Lancashire and Cheshire," C. T. G. Boucher, 6.30 p.m. ★ NORTHERN IRELAND BRANCH: College of Technology, Belfast, Chairman's Address, A. H. K. Roberts, 6.45 p.m.

Wed., Nov. 12.—MIDLAND COUNTIES BRANCH: Electricity Demonstration Hall, Irongate, Derby, "Factory Production of Precast Concrete," F. W. Gifford, 6.15 p.m. ★ YORKSHIRE BRANCH: Metropole Hotel, Leeds, "Tubes and Hollow Sections," G. B. Godfrey, 6.30 p.m.

Thurs., Nov. 13.—LONDON SECTION: 11, Upper Belgrave Street, London, S.W.1, "Technical Education and Professional Training," D. A. G. Reid, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 7.—Pepys House, 14, Rochester Row, Westminster London, S.W.1, Film Evening, 7 p.m.

Mon., Nov. 10.—SHEFFIELD AND DISTRICT SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, President's Address, "The Failure of Metals," A. G. Quarrell, 7.30 p.m.

Fri., Nov. 14.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Chairman's Address, "Development of the Iron and Steel Industry," P. Cameron, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Nov. 14.—Engineers' Club, Albert Square, Manchester, "The Machining of Large Light Alloy Components by Computer Control," J. Gregson and A. Flett, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Nov. 14.—Mining Institute, Neville Hall, Newcastle upon Tyne, "Notes on the Longitudinal Strength of Tankers," J. M. Murray, 6.15 p.m.

ROYAL SOCIETY OF ARTS

Wed., Nov. 12.—John Adam Street, Adelphi, London, W.C.2, "Modernizing the Railways—Motive Power and Operation," C. J. Allen, 2.30 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Wed., Nov. 12.—B.I.S.R.A., Hoyle Street, Sheffield, "The World's Largest Walking Dragline," C. McL. Cameron, 6.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues., Nov. 11.—CHEMICAL ENGINEERING GROUP: 14, Belgrave Square, London, S.W.1, "The Integrated Iron and Steel Works," W. B. Wright and W. Elland, 6 p.m.

Wed., Nov. 12.—CORROSION GROUP AND PLASTICS AND POLYMER GROUP: 14, Belgrave Square, London, S.W.1, "Plastics and other Polymers as Sources of Corrosive Vapours," H. G. Cole and Mrs. V. E. Rance; "Plastics for Protection Against Corrosion," A. C. Docherty and H. Hughes, 6.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., Nov. 12.—CONTROL SECTION: Manson House, Portland Place, London, W.1, "Some Applications of Control Technique in Astronomy," P. Fellgett, 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., Nov. 14.—39, Elmbank Crescent, Glasgow, "Slag Composition and Influence on Blast Furnace Practice," K. C. Sharp, 6.45 p.m.

Advanced Engineering Courses

Production Planning and Control Course. THE UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course, Monday, November 24, to Friday, December 5. Fee 50 guineas.

Electronic Computing Systems. Part II: Review of the Commercial Applications of Electrical Digital Computing Systems, by A. J. BURTON. SIR JOHN CASS COLLEGE, DEPARTMENT OF MATHEMATICS, Jewry Street, Aldgate, London, E.C.3. A course of eight to ten lectures on Wednesday evenings from 6.30 to 8 p.m., commencing Wednesday, January 14, 1959. Fee £1.

Pride of possession, as well as a face is reflected in the mirror finish of really good plating. For sound decorative chromium plating a nickel deposit approximately a hundred times the thickness of chromium is the only foundation which will give years of satisfactory service, against corrosion, rubbing and knocks. Ask Mond about this aspect of the nickel story. Mond have the resources for research and development and supply technical publications for guidance in the choice and use of modern materials.

An important exhibition covering every aspect of nickel-containing materials will be held at the Aeronautical College, Cranfield from 18th to 21st November, 1958. Write to us for your invitation.

Enough Nickel for all needs–

Plan ahead with **MOND NICKEL**

THE MOND NICKEL COMPANY LIMITED, THAMES HOUSE, MILLBANK, LONDON, S.W.1

TGA GN22

K

THIS
NARITE
DIE PRODUCED, AT
THE RATE OF
1,500
PER DAY,
OVER
250,000
STAINLESS STEEL
SINKS

LESS
WEAR
LESS WASTERS
MORE
PRODUCTION
MORE
PROFIT

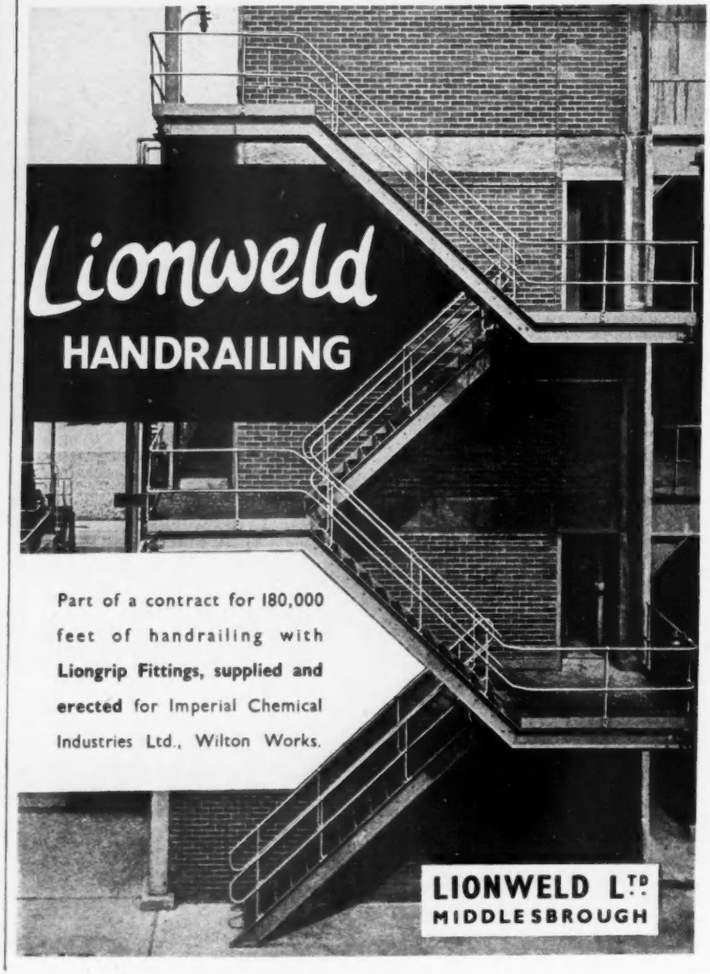
NARITE
The METAL FOR PRESS TOOLS
N. C. ASHTON LTD
ST. ANDREW'S ROAD, HUDDERSFIELD ENGLAND
TELEPHONE: HUDDERSFIELD 6263/4
CW 3269

PICK THIS UP
TO STOP
CORROSION!

To solve your corrosion problems, get in touch with Plus-Gas the Anti-Corrosion Specialists: their Technical Advisory Service covers the whole country.
Plus-Gas Formula 'A' Dismantling Fluid, (Rust Remover).
Plus-Gas Formula 'B' Protective Fluid.
Used and approved by all industries for many years.
Have you heard of
Plus-Gas Formula 'E'
External Metal Treatment
(Tannating Primer)?

See us at
STAND No. 630
Public Works Exhibition

PLUS-GAS COMPANY LTD
1/11 Hay Hill
London W1
Tel: HYDe Park 9566 9


Lionweld
HANDRAILING
Part of a contract for 180,000 feet of handrailing with **Liongrip Fittings, supplied and erected** for Imperial Chemical Industries Ltd., Wilton Works.
LIONWELD LTD
MIDDLESBROUGH

POLYPENCO NYLATRON GS TUBES

Now Available in 15 Sizes

. . . ranging from ½in. outside diameter with a ⅜in. inside diameter up to and including 2in. outside diameter with a 1½in. inside diameter. Lengths range from 4ft. to 8ft. depending on outside diameter.

NYLATRON GS SPECIAL PROPERTIES PROLONG WEARING LIFE OF WORKING PARTS

ONE of the newest industrial plastics available to designers is POLYPENCO Nylatron GS nylon—supplied in standard stock shapes. Nylatron GS is a molybdenum disulphide filled nylon composition.* This special formulation results in a product with proven property advantages :

Greater Rigidity
Parts have higher modulus of elasticity, show less deformation under load than nylon 66.

High Heat Distortion Temperature
Nylatron GS parts have higher heat distortion temperatures than standard nylon 66.

Low Thermal Expansion
Coefficient of thermal expansion is approximately 60 per cent. of nylon 66.

Low Surface Friction
When wear parts must run dry, Nylatron GS parts operate without lubrication.

High Wear and Abrasion Resistance
Part surfaces resist abrasion and demonstrate long wear in contact with metals.

The chemical and electrical properties are similar to nylon 66.

Nylatron GS is available in all standard shapes and sizes including rod, strip, tubing, tubular bar and plate. It is also available in powders for moulding. Write today for performance and application data on POLYPENCO Nylatron GS nylon.

** Polypenco and Nylatron are registered trademarks.*

** Patented*

POLYPENCO LIMITED

68/70 TEWIN RD., WELWYN GARDEN CITY · HERTFORDSHIRE

Tel.: WELWYN GARDEN 5581-2-3

POLYPENCO

A NEW JUMBO

strong in the arm

fast on it's feet!

With a road speed of 20 m.p.h., Jumbo 2-ton lorry mounted slewing crane offers unrivalled value. Diesel engine economy, hydraulic controls for simplicity, articulated jib and travelling hook with 200° slew. If you want *all* these features in one crane—it *must* be Jumbo.

SEND FOR FULLY ILLUSTRATED LEAFLET T.E. TODAY

TAYLORS OF SALFORD

mobile cranes to you . . .

Designers and Manufacturers:
F. TAYLOR & SONS (MANCHESTER) LTD., 142 BOLTON ROAD, SALFORD 6, LANCS.
Telephone: Pendleton 1341/2/3 *Telegrams: "Components" Manchester*

Big heads

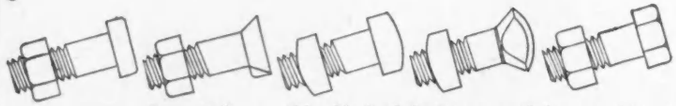
little heads

Hexagon and fiddle heads, Square heads, rare heads, countersunk and cheese.

Round necks, square necks, strength-enough-to-spare necks, oval necks, novel necks —even more than these.

The Lanarkshire range of standard bolts and nuts available from stock is quite staggering. Materials range through conventional black, bright, and brass to copper, stainless steel, and the special application bronze alloys.

Specials? Certainly! And with very little delay.



Buyers tell us our 'Monthly Stock List' is a great help in requisitioning. If you aren't yet receiving a copy, just send your name and address to

LANARKSHIRE BOLT LIMITED

HAMILTON · LANARKSHIRE · SCOTLAND
Telephone: Hamilton 1241/4

A better lookout for the welder

Welders' eyes are highly vulnerable to attacks by invisible ultra-violet and infra-red rays. Undoubtedly the best way to overcome this hazard is to specify the appropriate Chance Protex (Regd.) and Protal protective glass.

PROTEX (Regd.) glass filters reduce the ultra-violet and infra-red rays to such an extent that they can do no harm. Complies fully with BS.679.

PROTAL glass should be used when welding with flux. It protects from harmful ultra-violet rays and absorbs the excessive sodium yellow and lithium red light. Complies fully with BS.679.

Chance
PROTEX and PROTAL
Chance Glass for Science, Industry and the Home

For further information please write for our detailed folder FG2/B.
Dept. H.S., Chance Brothers Limited, Glass Works, Smethwick 40, Birmingham.
LONDON OFFICE: 29/30 ST. JAMES'S STREET, LONDON, S.W.1.

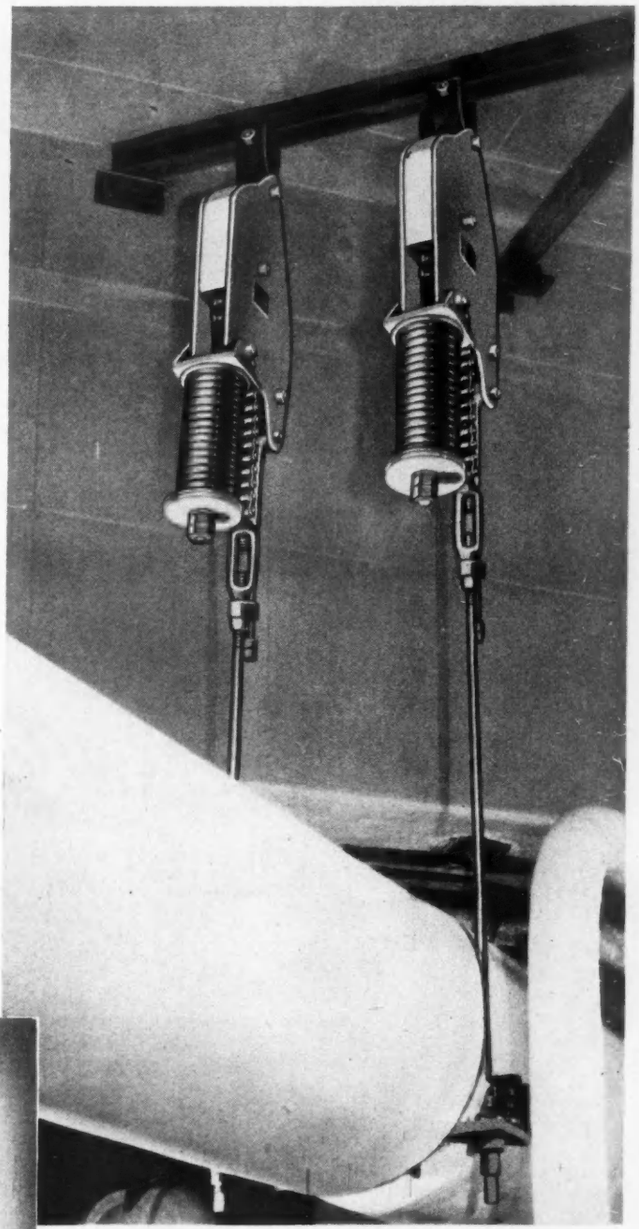
CON-TEN

constant tension supports

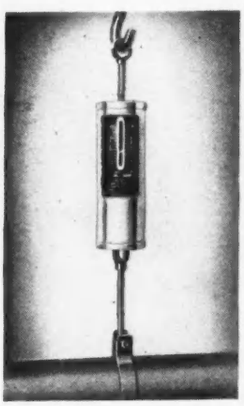
FOR LOADS UP TO 8 TONS
PIPE MOVEMENTS UP TO 18″

High-pressure steam piping is subject to wide variations in temperature, which produce considerable expansion and contraction. Unless the pipe supports can absorb and compensate for this movement, severe stresses are set up which may result in fracture. The " Con-Ten " Pipe Support is designed to cradle any type of piping with constant tension under all conditions, throughout the range of movement. " Con-Ten " is installed, with eminently satisfactory results, in power stations, oil refineries, chemical and industrial plants throughout the world.

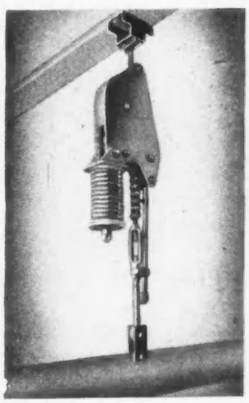
British Patent Nos. 474008 720074 720075 697987 657318
U.S.A. Patent Nos. 2129320



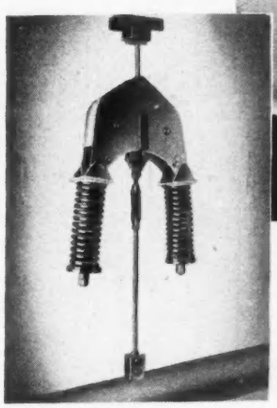
Ferrybridge " B " Power Station, Central Electricity Generating Board, Yorkshire Division. H.P. Steam pipes supplied and installed by Stewarts and Lloyds, Ltd.



Leibfried Red Top Pipe Supports for load from 100 to 5,000 lbs. and total travel of 3″.

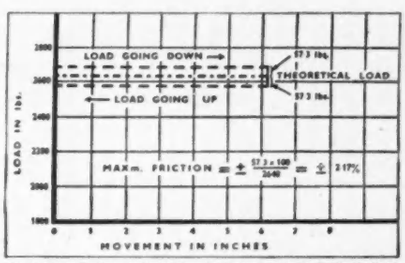


Conventional type " Con-Ten" Supports for loads of up to 2 tons with a total vertical movement up to 12″.



Duplex " Con-Ten " Supports for load of up to 8 tons with a total vertical movement up to 12″. This type is acknowledged as one which produces minimum friction and kinematic variation. It has been specially designed for any applications where exceptional accuracy is demanded.

From graph it can be seen that the maximum friction is equivalent to 2.17% of the applied load.

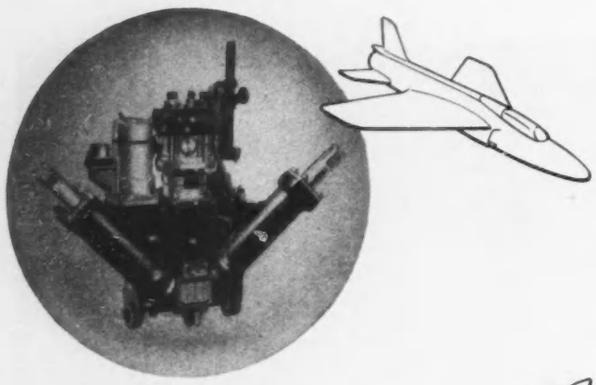


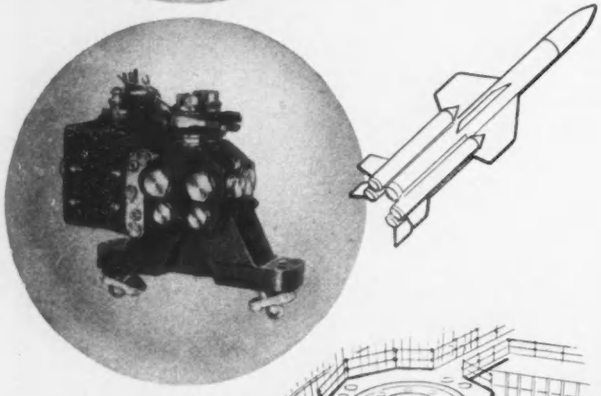
DUPLEX 'CON-TEN' SUPPORT

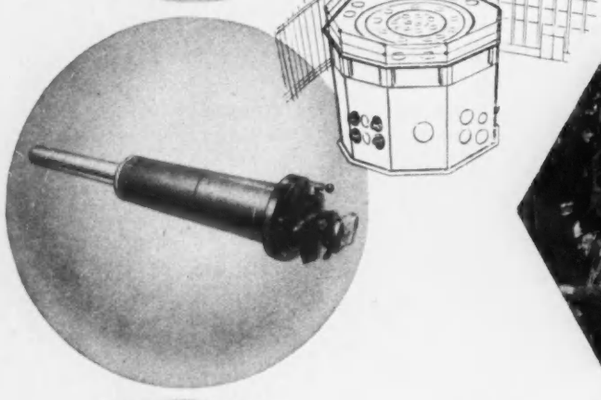
BRITISH INDUSTRIAL

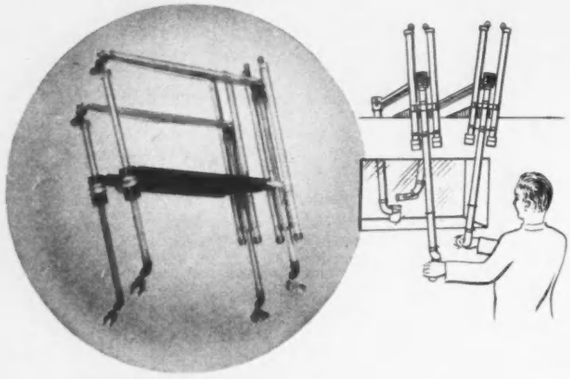
ENGINEERING COMPANY LIMITED

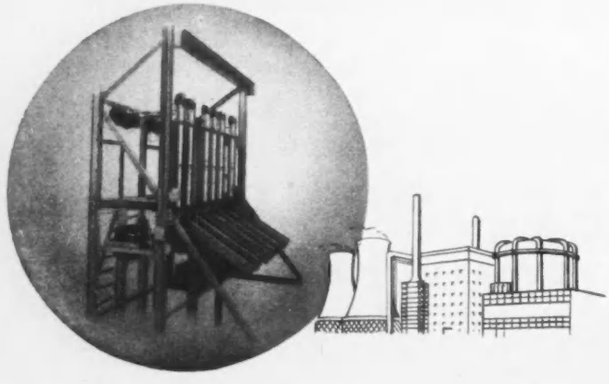
CORONATION WORKS, HAINGE ROAD, TIVIDALE, TIPTON, STAFFS.











In Many Spheres...

Hobson

Skill and experience in engineering has long been successfully applied in the design, development and manufacture of various specialised components of high precision character.

Present production is concerned mainly with advanced projects relative to the aircraft and nuclear power industries.

We have a technical staff capable of dealing with the many problems of modern engineering technique and invite enquiries regarding projects to which our wide experience can usefully be applied.

TYPICAL EXAMPLES OF HOBSON PRODUCTS

Hydraulic Jacks and Servos
Electro-Hydraulic Servo Actuators
Hydraulic Pumps and Motors
Liquid Flowmeters
Engine Control Systems
Mercury Manometers
Remote Reading Contents Gauges
Remote Handling Equipment
Honeycomb Isotope Manufacturing Machines
Electro-Mechanical Control Systems for Atomic Reactors
Specialised Gearboxes
Atomic Reactor Ancillary Equipment
Hydraulic Variable Speed Drives

H. M. HOBSON LIMITED
WOLVERHAMPTON ENGLAND

OUR MEDIUM IS **STEEL**

our vocation is...

CONSTRUCTIONAL STEELWORK

LAMBHILL IRONWORKS LIMITED

GLASGOW, N.2

'Phone: POSSIL 8386-7-8. 'Grams: "ERECTIONS" GLASGOW

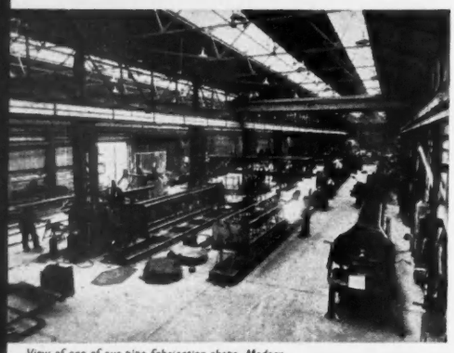
From drawing board to finished framework we place a wealth of specialised knowledge and practical experience at your command. Modern plant and methods exactly co-ordinated to the purpose of the job ensure the utmost economy consistent with trustworthy achievement. "Steelwork from Lambhill" is your guarantee of steadfast, intelligent workmanship exactly applied to your requirements with speed and efficiency.

ALSO AT: LONDON · NEWCASTLE · SHEFFIELD

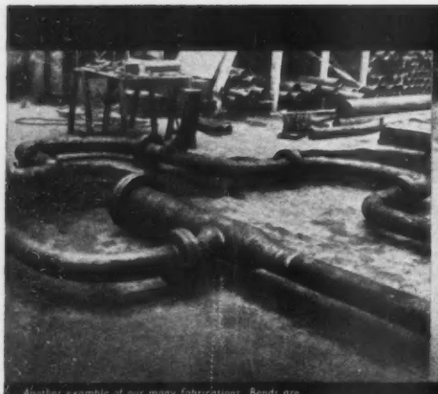
Aerial view of Crown Works, Sunderland

PIPE

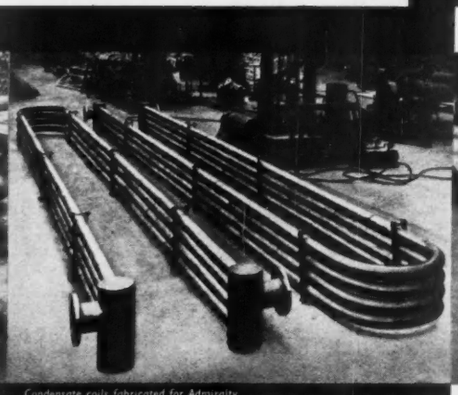
World famous for every kind of pipe fabrication in a wide variety of materials, STEELS and LOW'S are producing installations of exceptional quality and accuracy – for the marine, chemical and oil industries, the great nationalised industries, and atomic energy projects.



View of one of our pipe fabrication shops. Modern manipulators in foreground.



Another example of our many fabrications. Bends are machine made cold and unfilled, and stress-relieved.



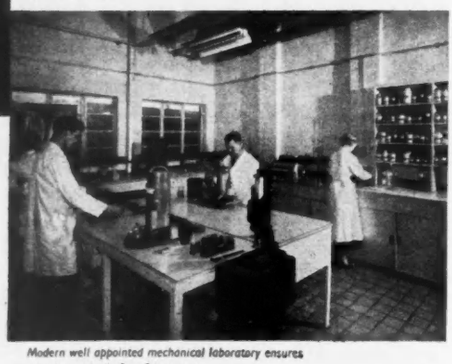
Condensate coils fabricated for Admiralty.

Aluminium alloy cargo line piping, 8" nom. bore x 4 SWG thick, flanges ½" thick.

Pipe layouts are speedily prepared from site measurements and drawing details, backed by comprehensive metallurgical and testing laboratory facilities. Fabrication methods include all new and established principles of manipulation, welding, flanging and screwing in all materials normally used in the manufacture of tubes. Fabricated to British and American standards.

Special mild steel pipework for high pressure hot water process circuit.

FABRICATION

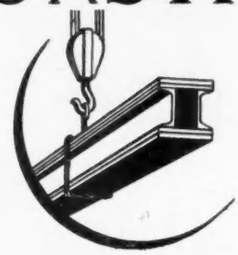


Modern well appointed mechanical laboratory ensures a high standard of prefabrication.

STEELS ENGINEERING INSTALLATIONS LTD., Sunderland,

and their Associates ARCHIBALD LOW & SONS LTD., Glasgow.
HOME & OVERSEAS SALES OFFICE: 143 Sloane St., S.W.1.
Tel: Sloane 6178

The STEEL CONSTRUCTION CO. LTD.



Whitegates Engineering Works
MOTHERWELL • SCOTLAND
Telegrams: "DEVISERS, WISHAW" Telephone: WISHAW 289 & 290

Contractors to the Admiralty, War Office, Air Ministry and H.M. Office of Works

LONDON OFFICE: LONG LANE, HILLINGDON, MIDDLESEX.
Telephone: UXBRIDGE 3925

All Classes of
STRUCTURAL STEEL WORK

PLATED TUBE WORK
Riveted or Welded

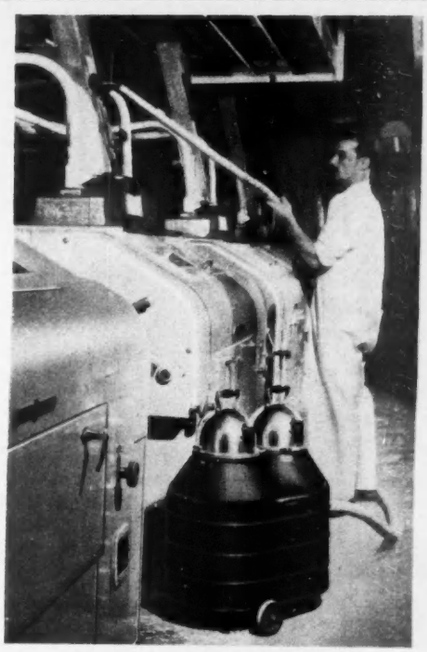
THE MASTER CLEANER

causes extra labour

The greatest enemy of efficient production—DUST, whether it is creating a fire risk, damaging machinery, blanketing heat and light, jeopardising health, ruining paint or causing extra labour can, unknown to you, gradually whittle down your profits. You cannot SEE the NEED—but it is there all the same. Eliminate dust with NEW WELBECK industrial suction cleaners—the most advanced and efficient machines on the market today. Your premises **need** NEW WELBECK to restore lost profits.

Write now for further information to DEPT. 34.

WE SERVE THE LEADERS OF INDUSTRY



McDOUGALLS use NEW WELBECK industrial suction cleaners.

The 'DUPLEX' model cleaner in use at McDougalls, cleaning the base of a plansifter.

By appointment to H.M. The Queen Suppliers of Vacuum Cleaners

NEW WELBECK LTD.

HEAD OFFICE & WORKS:
Moulsecoomb Way, Brighton, 7, Sussex
Tel.: Brighton 61666 (PBX)

LONDON OFFICE:
6 Cavendish Square, London, W.1
Tel.: LANgham 1517 (PBX)

BRANCHES AT BIRMINGHAM, MANCHESTER, SCOTLAND & EIRE

N29

These buildings went up faster—

This announcement is of vital interest to you.

It's news—news of price reductions in a period of rising costs.

It can make that building project you may have scheduled for the future an economic proposition

NOW!

HERE'S WHY

- Advanced techniques eliminate all waste and delay.
- Firm quotations are given at design stage.
- Work commences on site months earlier.
- Construction frequently completed in half the average time.
- The period of unproductive capital investment is drastically reduced.

And you get a building of better quality at a lower cost!

Beecham Buildings

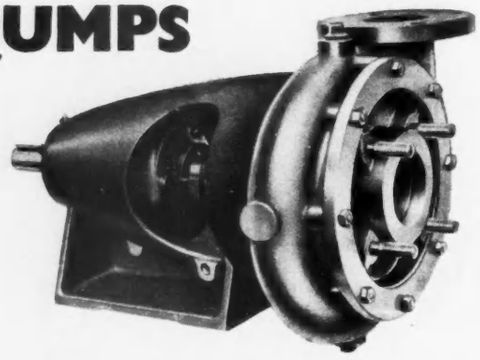
Beecham Buildings, a quick return for your capital

Write or telephone today:

BEECHAM BUILDINGS LIMITED

Shipston-on-Stour, Warwickshire. Tel. Shipston-on-Stour 315 (6 lines)
AP 211/81

STAINLESS STEEL PUMPS



made by

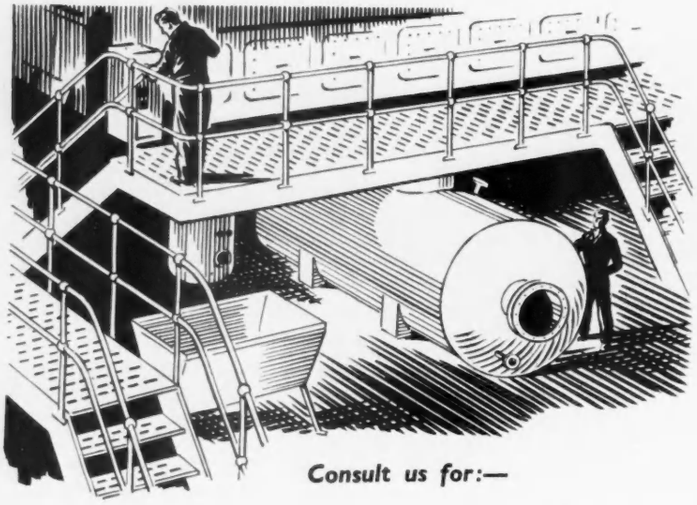
Girdlestone

Centrifugal Pumps available with liquid end or complete pump in 18/8/3 stainless steel. Packed stuffing boxes or mechanical seals.

For details send for this folder now!

GIRDLESTONE PUMPS LTD.
23, Davies St., W.1. MAYfair 1354

T.113



Consult us for:—

OPEN STEEL FLOORING
TUBULAR HAND RAILING & STANDARDS
STEEL PLATFORMS & STAIRCASES
TANK WORK
PRESSED STEEL GUTTERS
GENERAL PLATE WORK & FABRICATIONS

E. HAYWARD & CO. (Fabrications) LTD.
POUNTNEY STREET · WOLVERHAMPTON
Telephone No.: Wolverhampton 23300

for all DISTRIBUTION TRANSFORMERS

to B.E.B. Specification T.I. (1958)

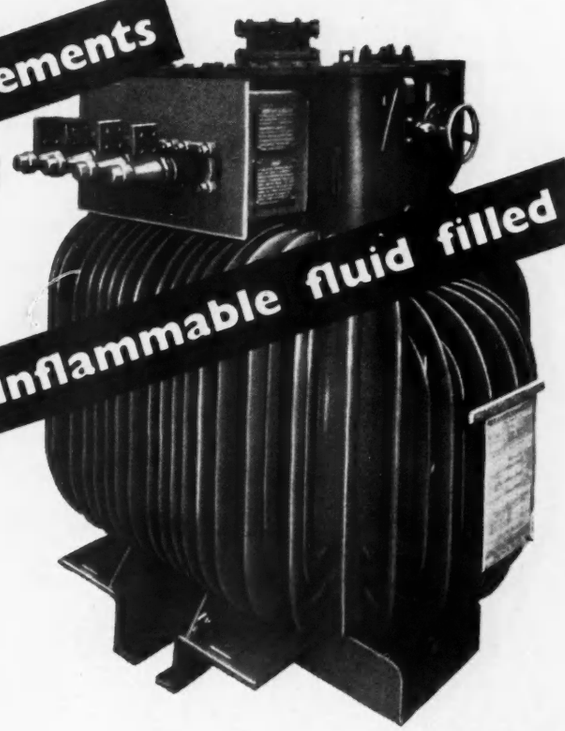
300 kVA transformer for a British Electricity Board

or

to individual requirements

oil filled

1000 kVA transformer for a Lancashire cotton mill



non-inflammable fluid filled

250 kVA transformer for a Spanish power station

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

An A.E.I. company

REMEMBER POPPY DAY

Leading Electrical Progress

E/A801

SEEGER CIRCLIPS are 360° safe
Automotive Engineering Limited
One of the Sheepbridge Engineering Group
The Green, Twickenham, Middlesex.
Telephone: Popesgrove 2206/9
Telegrams: Motif, Twickenham

THE ROLLS-ROYCE
AIRCRAFT ENGINE ALTITUDE TEST PLANT AT DERBY HAS THREE

Precipitron
REG TRADE MARK
SOLE LICENSEES

ELECTROSTATIC AIR FILTERS FOR CLEANING AIR SUPPLIES

PLANT 'A' cleans 320,000 c.f.m. for the main compressor system in the Exhauster Station building.

PLANT 'B' cleans 160,000 c.f.m. for the compressor system in the Input Circuit building.

PLANT 'C' cleans 224,000 c.f.m. supplied direct to the aircraft engine under test.

Electrostatic Air Cleaning was pioneered by Sturtevant in the United Kingdom with PRECIPITRON AIR FILTERS detailed in our publication E7106.

This plant is among the largest electrostatic air filter installations in this Country.
PRECIPITRON was chosen because it measures up to Rolls-Royce standards.
Consulting Engineers, McLellan and Partners in association with Merz and McLellan.

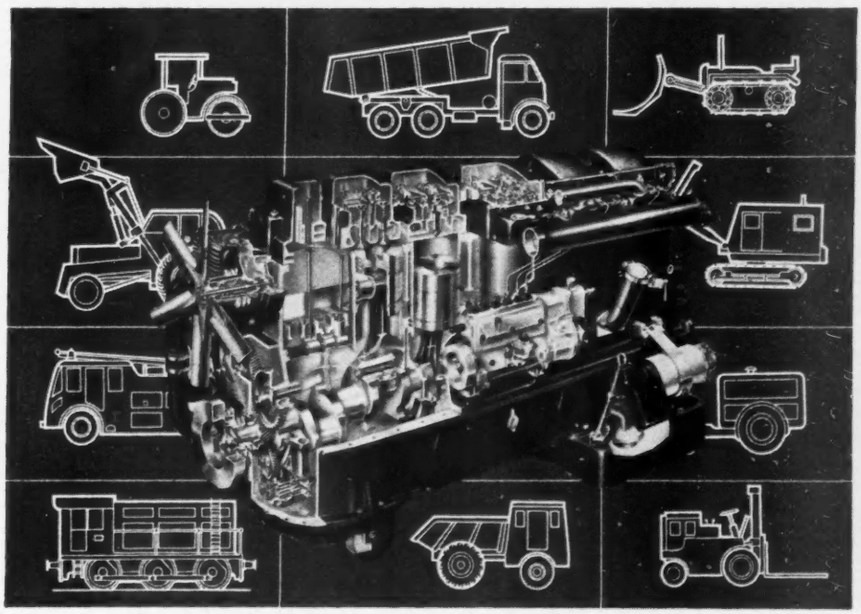
STURTEVANT ENGINEERING CO. LTD.
Southern House, Cannon Street, LONDON, E. C. 4.

AUSTRALIA: STURTEVANT ENGINEERING CO. (AUSTRALASIA) LTD. 400 SUSSEX STREET SYDNEY N.S.W.

NOW! A.E.C. OFFER FULL RANGE OF DIESELS

☆ *45 to 275 b.h.p.*

☆ *275 to 1100 cu. in.*



With the introduction of the new AV 1100 (1100 cu. in. capacity), 275 b.h.p. normally aspirated, wet-liner diesel engine, A.E.C. offer a very comprehensive range of extremely dependable power units for a wide variety of industrial uses. Built to meet the exacting conditions in which industrial plant and similar equipment has to work, A.E.C. diesel engines are also noted for maximum fuel economy and easy maintenance.

See the full range of A.E.C. Industrial Diesels at the Public Works Exhibition, Stand 528

AEC SOUTHALL

A.C.V. SALES LTD., MARINE AND INDUSTRIAL DIVISION, A.E.C. Works, Southall, Middlesex

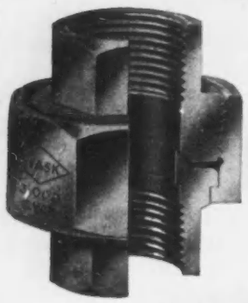
THE A.C.V. GROUP OF COMPANIES INCLUDES A.E.C. AND THE MAUDSLAY MOTOR CO.

MI/482

FORGED STEEL PIPE FITTINGS

Screwed A.P.I., B.S.T.P.T. or socket weld. Materials: Carbon steel, chrome molybdenum or stainless steel.

C.W.P. non-shock
2000 lbs series
3000 lbs series
6000 lbs series



FORGED STEEL UNIONS

Integral seats or inserted stainless steel, chrome molybdenum or bronze.

WALTER SLINGSBY
& CO. LTD.

RAILWAY WORKS, KEIGHLEY

'Phone: 3749 'Grams: "Malleable Keighley."

ELECTRIC HOISTS

approved thousands of times

■

Capacity 150—10,000 kg

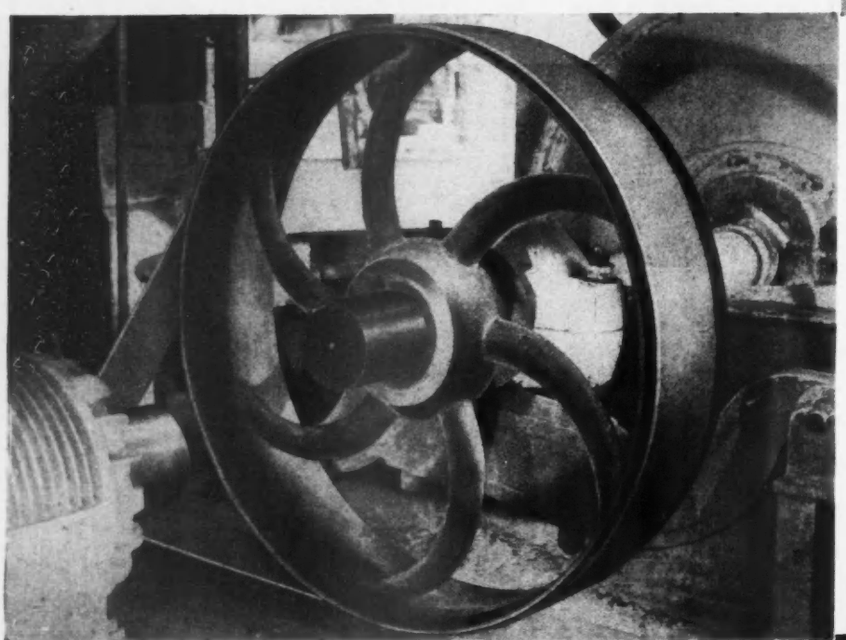
■

Small Electric Hoists
"Liftikus"
with one or two speeds and capacities between 125 and 750 kg

SWF MÜNCHEN 25

BAIERBRUNNER STRASSE 17
BAVARIA FEDERAL REPUBLIC OF GERMANY

STEPHENS **Miraclo**



30 h.p. Bentley & Jackson Beater, Pulleys: 10¾in. × 9in. at 725 r.p.m. to 48in. × 12in. at 158 r.p.m. with 44in. centres. Belt: Miraclo type 2BL, 8in. wide.

"CONSISTENTLY SATISFACTORY SERVICE"

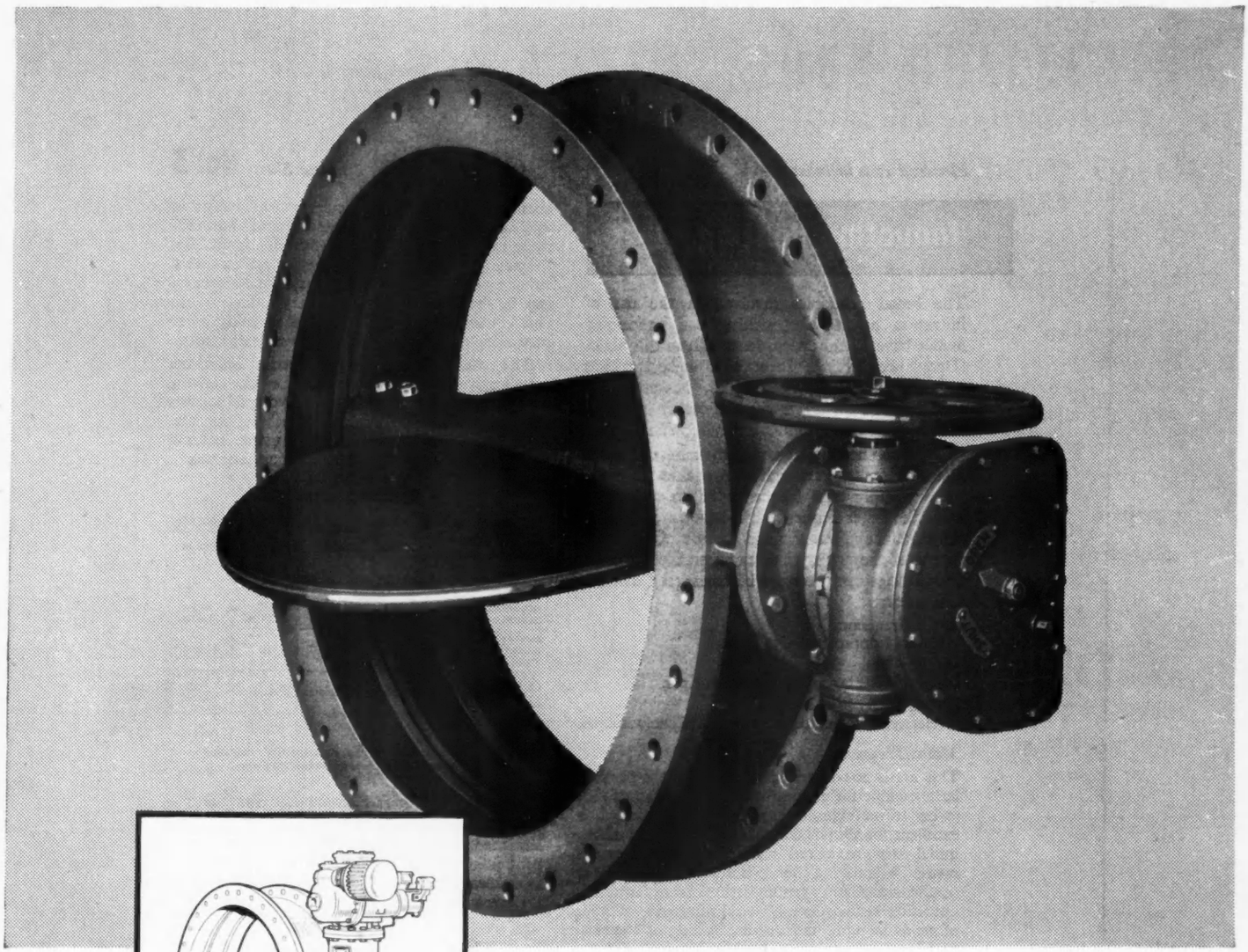
No sign of slip, stretch or loss of power when you fit Miraclo—the nylon belt with the chrome leather driving face. Miraclo lasts longer, needs virtually no maintenance and speeds up production however difficult the drive.

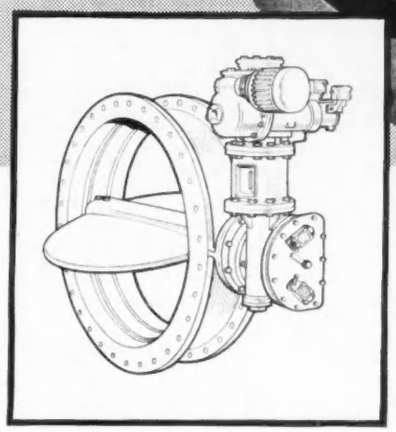
The belt illustrated has given over 2 years' "consistently satisfactory service" and is still in good condition—no wonder the Directors now specify Miraclo for all similar machines.

Write today for this 12-page colour Brochure No. 100 which tells you . . . HOW TO DESIGN A MIRACLO DRIVE.

STEPHENS BELTING COMPANY LTD.
SNOW HILL · BIRMINGHAM 4
Northern Office and Works: IRA STEPHENS LTD. Ashton-under-Lyne, Lancs.

S. 72





BUTTERFLY VALVES
FOR TIGHT SHUT OFF

Combining positive drop-tight shut-off, with the natural advantages of the Butterfly principle, the Blakeborough Rubber Sealed type is an attractive proposition for a wide variety of moderate-pressure services, of which condenser cooling water is a notable example.

The valves are offered for working pressures up to a maximum of 50 psi. (temperatures from -20° to +200°F), in all regular sizes from 12" to 84" bore, and in manual and power operated versions, the latter including electric motor, hydraulic or pneumatic cylinder, and pneumatic diaphragm-motor types. We shall be glad to submit proposals covering either standard valves or special applications on enquiry.

BLAKEBOROUGH

J. BLAKEBOROUGH & SONS LIMITED, BRIGHOUSE, ENGLAND

ndh 363

Electrical Aids in Industry *Data Sheet* **No. 3**

Induction Heating - 2

The broad principles involved in the use of induction heating for melting and processing metals have already been dealt with in this series (Data Sheet No. 2). In order to make a critical examination of its possibilities, however, the potential user should be aware of certain technical factors which must influence his decisions.

Induction heating, of course, demands the use of alternating current which is available from the public supply at a frequency of 50 cycles per second. Higher frequencies, however, are desirable for certain applications and can be obtained by means of the appropriate conversion equipment. Frequencies can therefore be considered in three categories:

Mains Frequency
(direct from mains)—50 c.p.s.

Medium Frequency
(machine generator)—50-10,000 c.p.s.

High Frequency
(electronic generator)—up to about 2,000,000 c.p.s.

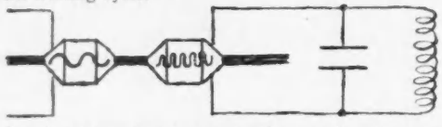
Mains Frequency

This needs no conversion equipment; it is particularly suitable for melting large pieces of scrap and, owing to the vigorous stirring forces produced, is excellent for alloy making. It has the merit of low initial cost compared with the high frequency method of melting, but is not so suitable for the production of high grade steel. Mains frequency induction heating is also useful for stress-relieving of welds in pipes and vessels, heating of chemical vessels, pipelines, injection moulding machines and press platens.

A typical example of the use of mains frequency is the coreless induction melting furnace which can be connected direct to the public 3-phase supply. Such a furnace rated at 120 kW, with a holding capacity of 2,240 lb., will give a throughput of 5,000 lb. per hour of hot cupola metal superheated from 1,350°C to 1,450°C.

Medium Frequency

Motor generators ranging from 10 kW to 1,500 kW or more at frequencies up to about 10,000 c.p.s. are widely used for heating for forging, melting from 100 lb. to 10 tons, hardening, annealing, etc. A bank of capacitors maintains a high power factor during the heating cycle.



Another form of generator for frequencies of 1 to 2 kc.p.s. and powers around 250 kW, useful for forge heating and melting high temperature aircraft alloys, is a 6-anode steel tank mercury arc inverter.

High Frequency

Metal hardening and metallurgical processing are best handled by high frequency induction (up to about 2,000,000 c.p.s.), particularly when a very thin case is required or when the section of the workpiece is too small to heat satisfactorily at medium frequency. These high frequencies are produced either by an electronic h.f. generator or a mercury-gap h.f. generator; high frequency induction can deal efficiently with such jobs as hardening lawnmower cylinders and cutters, bars and axle shafts.

The choice of frequency depends upon the metallurgical requirements and the size of the component to be treated. The following table gives the practical relationship between size and frequency, and may be used as a guide to the choice of generator, subject to metallurgical considerations.

Optimum Value

FREQUENCY C.P.S.	3,000	10,000	500,000	2,000,000
MIN. DEPTH OF HARDNESS POSSIBLE	.060 in.	.040 in.	.020 in.	.010 in.

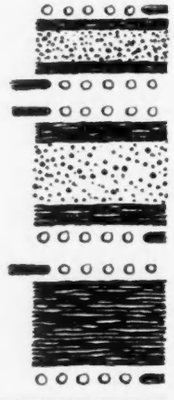
Practical Values

MIN. DEPTH HARDNESS EXPECTED	.150-.200 in.	.100-.150 in.	.030-.050 in.	.015-.030 in.
MIN. DIA. SURFACE HARDENING THIN CASE	2" & over	1" to 3"	½" to 2"	¼" to ½"
MIN. DIA. SURFACE HARDENING DEEP CASE	2" & over	2" & over	1" & over	not suitable
MIN. DIA. THROUGH HARDENING	1" & over	½" to 2"	¼" to ¾"	not suitable

These are of course very approximate since they also depend on metallurgical considerations.

Power required for H.F. Induction Hardening

The high frequency power required per sq. in. of hardened surface depends upon the amount of metal behind the surface. Higher powers and shorter heating cycles are necessary for thin cases and when the thickness of metal behind the surface is small.



0.03" to 0.04" requires 1 sec. or less at 10 kW or more per sq. in.

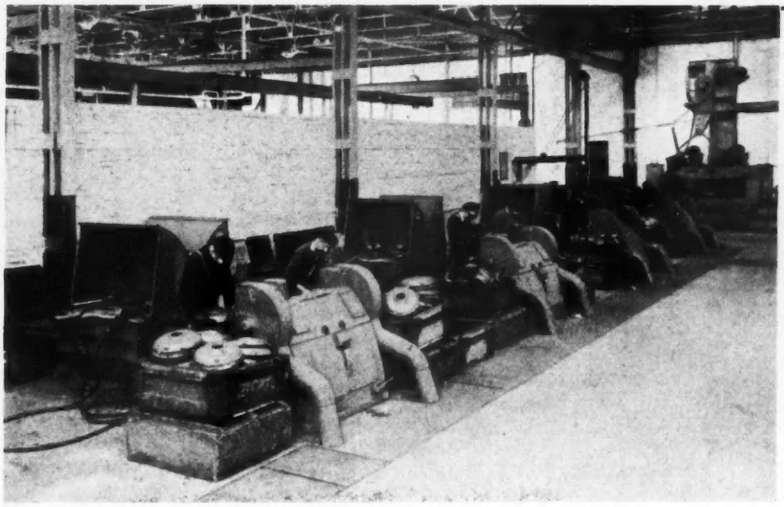
0.1" to 0.2" with a large mass of metal behind the surface, requires 10-60 secs. at 2 kW per sq. in.

Through hardening requires 10-12 kWh per lb.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association. Excellent reference books (8/6, or 9/- post free) are available on electricity and productivity—"Induction & Dielectric Heating" is an example.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

Issued by the Electrical Development Association, 2 Savoy Hill, London, W.C.2 6515



DUST COLLECTING

IN THE NEW DRESSING SHOP OF

THE HILL TOP FOUNDRY CO., LTD.
WEDNESBURY

includes

14 "DUSTROL" Fettling Benches
(REG'D)

together with Hill Top 3 speed grinders incorporating B.S.C.R.A. hoods with all ducts underground and discharging to a wet collector with automatic sludge discharge.

We can supply ANY TYPE OF COLLECTOR, WET OR DRY, and so are in a position to give unbiased advice on the best system of collection to solve your particular problem.

"DUSTROL" Fettling Benches are designed and made solely by us. . . . . .

NEWTON COLLINS LTD.
BARFORD STREET WORKS · BIRMINGHAM 5
SPECIALISTS IN DUST AND FUME REMOVAL FOR NEARLY 40 YEARS

Galtona
TRADE MARK
Ground Thread Taps

At Charles Winn & Co. Ltd., the Birmingham Valve makers, 'Galtona' Ground Thread Taps are proved entirely dependable for high performance and lasting precision under all conditions of service . . . on radial drills, capstan lathes, etc. They can be supplied for all types of material, including tough brass and bronze, steel and cast iron, and in all thread forms.
Popular sizes ex stock. Informative catalogue available on request.

FOR HIGH PERFOMANCE, PRECISION AND LONG-LIFE

Illustration at top shows the machining of a valve head on a standard valve. Lower illustration is of a boss being tapped on the body of a 6in. cast iron valve, the tapping being 1¼in. B.S.P. Both components are in continual production at Charles Winn's

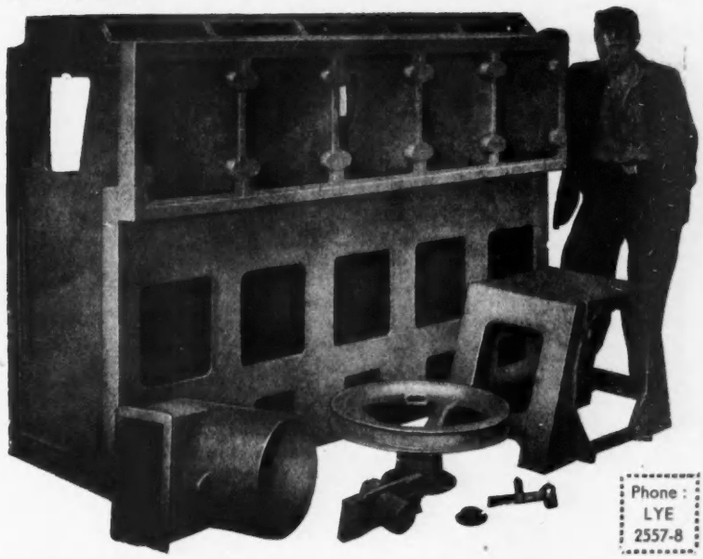
Richard Lloyd Limited
GALTON HOUSE, ELMFIELD AVENUE, TYBURN, BIRMINGHAM, 24
Telephone: Ashfield 1801. Telegrams "Cogs, Birmingham"

NORTHERN AREA OFFICE: A. V. Green, Britannia House, Wellington Street, Leeds. Phone: Leeds 21212
LONDON AREA OFFICE: A. J. Percy, 240 Romford Road, Forest Gate, London, E.7. Phone: Maryland 7304/5

L

GREY IRON CASTINGS *from 2 OUNCES to* 25 TONS

In the production of Grey Iron Castings we have concentrated on these four vital points: accurate moulding to specification; unvarying quality throughout the run; clear finish and excellent machining surfaces; competitive prices. We shall be pleased to advise you on any particular castings problem. Our long experience is at your service.

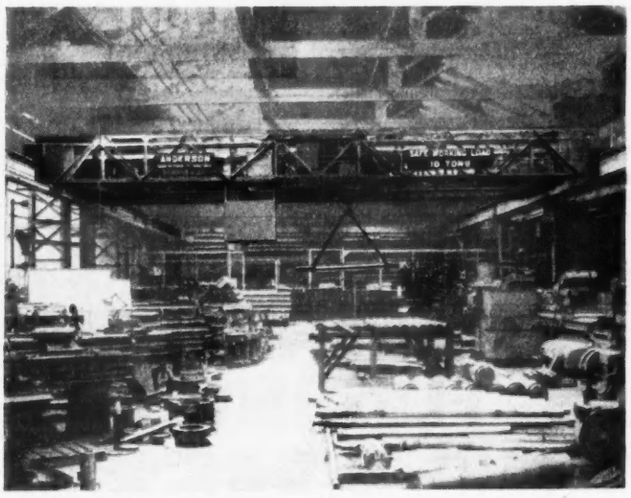


Phone: LYE 2557-8

S. MOLE & SONS (GREEN LANE FOUNDRY) LTD. BOTT LANE · LYE · STOURBRIDGE · WORCS.

ANDERSON Electric Overhead Cranes

★ RUGGED ★ RELIABLE ★ ECONOMICAL



10-ton E.O.T. Crane x 44 ft. span

Some Further Exclusive Features:

- LOW MAINTENANCE
- ACCESSIBILITY
- SUPERIOR VISIBILITY
- INTERCHANGEABLE SPARES

London Office: Finsbury Pavement House, E.C.2. *Tel: MONarch 4629*

ANDERSON

THE ANDERSON-GRICE CO. LTD.
TAYMOUTH ENGINEERING WORKS, CARNOUSTIE, SCOTLAND

Telephone: Carnoustie 2214/5. Grams: "DIAMOND," CARNOUSTIE

DREDGING PLANT

To the Largest Dimensions and Capabilities

PATENT CUTTER HOPPER DREDGERS. PATENT DIPPER DREDGERS. BUCKET DREDGERS. GOLD AND TIN RECOVERY DREDGERS. FLOATING CRANES

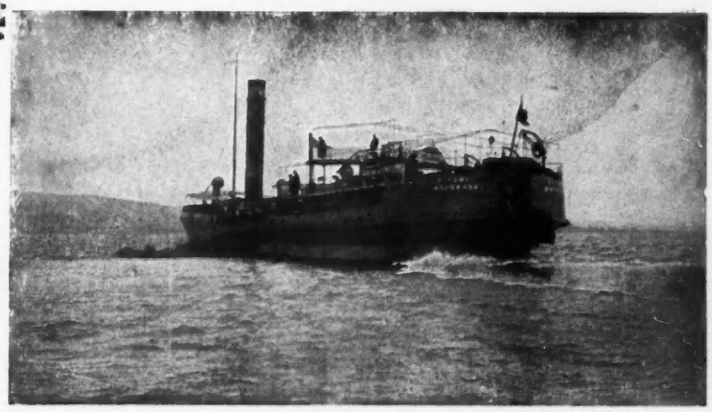
Hopper Barges, Screw Steamers, Side & Stern Paddle Wheel Steamers, Tugs, &c.
New Buckets, Links, Pins, Gearing, etc., supplied for existing Dredgers

FLEMING & FERGUSON, LTD.

SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND

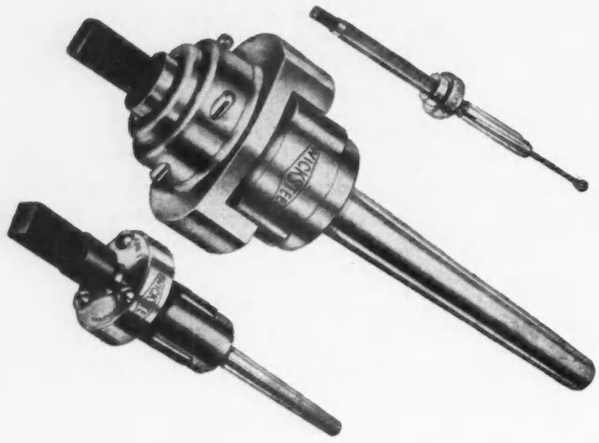
'Phone:—Paisley 4121. Tele. Add.—"Phœnix, Paisley."

London Agents: Messrs. Nye & Mennies, Ltd., Capel House, 62, New Broad St., E.C.2
'Phone—London Wall 4846



TWIN-SCREW TRAILING SUCTION HOPPER DREDGER "FITZROY"
built for the
QUEENSLAND GOVERNMENT, FOR ROCKHAMPTON
Dredging capacity: 1,000 cubic yards per hour

Vessel can suck from its 800-ton hopper delivering to a distance of 1,000 feet, to a height of 16 feet.



TUBE EXPANDERS

FOR ALL PURPOSES.

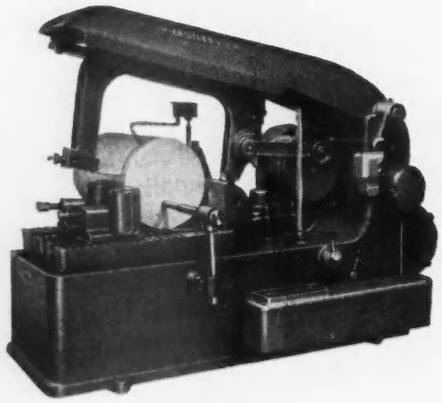
As supplied to the Admiralty, British Electrical Authority, Railways, Oil Refineries, leading Boiler Makers and industrial users.

LEADING TUBE EXPANDER MANUFACTURERS FOR OVER 70 YEARS

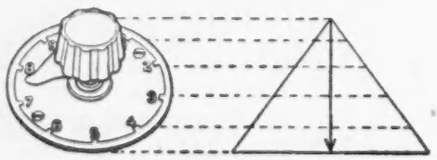
WICKSTEED

REGD. TRADE MARK

FOR ALL INDUSTRIES, ALL COUNTRIES.



YOU INCREASE THE PRESSURE TO SUIT THE SECTION



CHARLES WICKSTEED & CO (1920) LTD.

HYDRAULIC CONTROL

SAWING MACHINES

Unique in design. Proved in practice. One simple setting and it's capable of dealing with any section within its range with blades of one pitch of tooth. The blade commences and finishes each cutting stroke with no pressure whatsoever. What a saving in blades!

FAMOUS FOR SPEED ACCURACY AND RELIABILITY

KETTERING. Tel: Kettering 3113

ASHWORTH ROSS DUROS

ROAD and RAIL WEIGHBRIDGES

At your service

Built to give years of trouble free service Duros Weighbridges embody all the latest improvements in design and construction and are the result of over 70 years experience in this field.

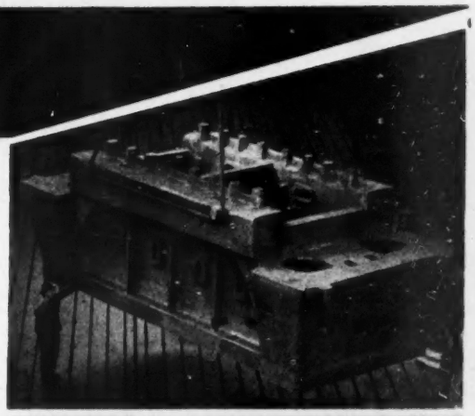
Illustrated brochures fully describing these machines are available—write for one now—without obligation.

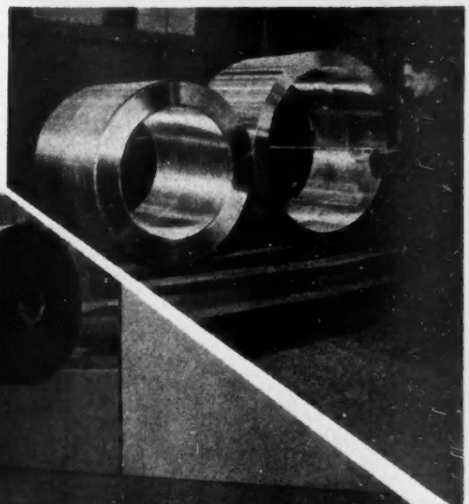
ASHWORTH ROSS & CO LTD
Weighing Machine Makers
MIDLAND IRON WORKS, SCOUT HILL, DEWSBURY, YORKSHIRE
Telephone : Dewsbury 1760/1 *Telegrams* : "Duros, Dewsbury"

For highly stressed Steel Forgings and Castings we recommend our BV Vacuum Steel

Forgings of plain carbon and alloy steels from vacuum degassed ingots weighing up to 150 tons, open hearth or electric quality, also of complicated shape and design, adequately heat treated.

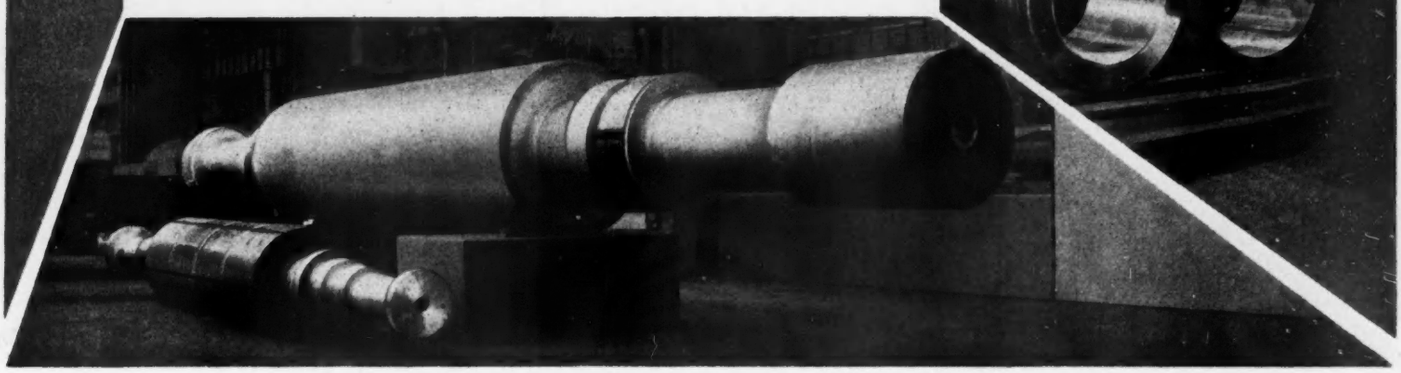
Intricate Steel Castings for maximum stresses, of high quality plain carbon and alloy open hearth and electric steels, in cast weights of 3 cwts. to 400 tons.
Drop Forgings, Pressed Parts and Seamless Rings

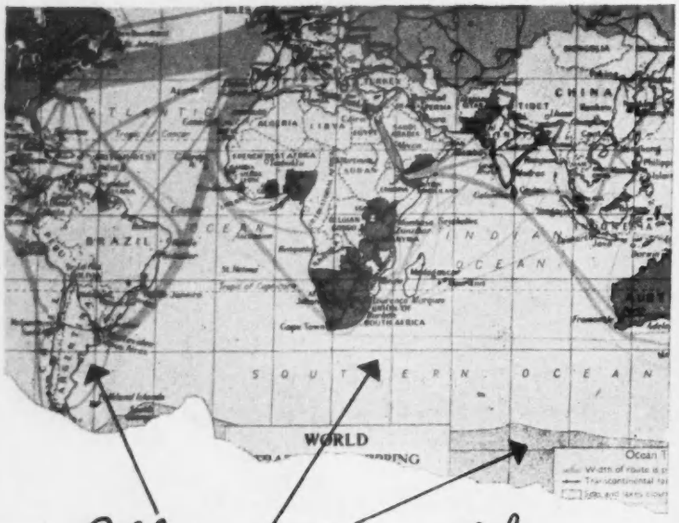




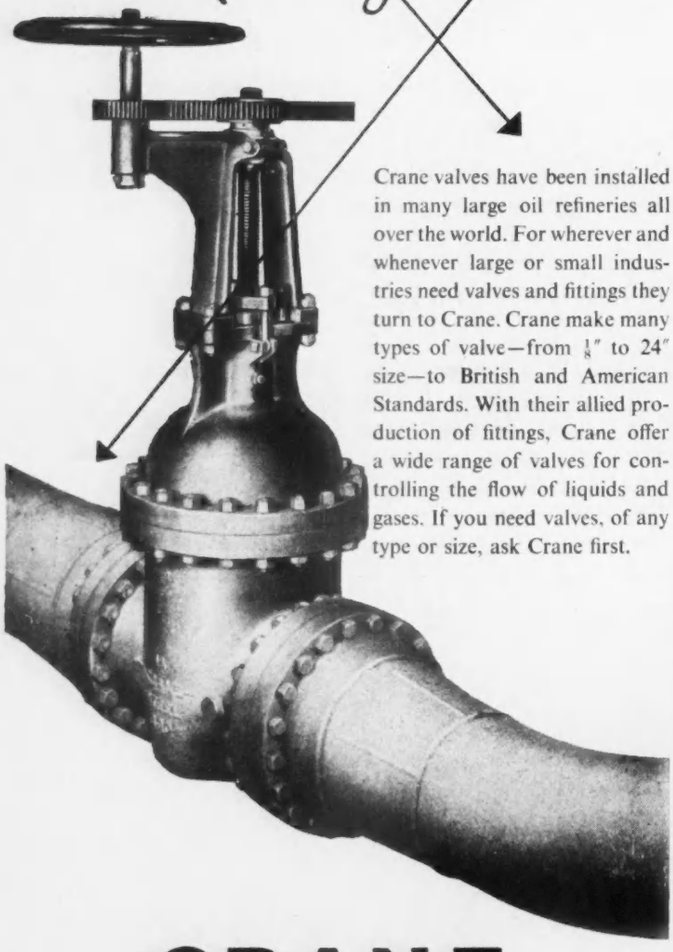
Bochumer Verein für Gusstahlfabrikation AG. BOCHUM

Representatives for the U. K.: THE STAHLUNION COMPANY LIMITED
61 Pall Mall, London S. W. 1. Telephone: Whitehall 5315 (7 lines)





All over the world you will find Crane valves and fittings



Crane valves have been installed in many large oil refineries all over the world. For wherever and whenever large or small industries need valves and fittings they turn to Crane. Crane make many types of valve—from $\frac{1}{8}$" to 24" size—to British and American Standards. With their allied production of fittings, Crane offer a wide range of valves for controlling the flow of liquids and gases. If you need valves, of any type or size, ask Crane first.

CRANE

VALVES OF BRONZE, CAST IRON AND CAST STEEL

A10

CRANE LTD., 15-16 RED LION COURT, FLEET STREET, LONDON, E.C.4. Works: IPSWICH

Branches: Birmingham, Brentford, Bristol, Glasgow, London, Manchester

The TREWHELLA MONKEY WINCH

FOR QUICKER MOVING OF HEAVY PLANT

Handle machinery quicker and with fewer men this way. On the factory floor too the Monkey Winch is a big cost cutter and labour saver. Excellent for pulling plant in place. Our literature gives full information.

May we send you copies?

TREWHELLA BROS., PTY., LTD., 117, Rolfe Street, Smethwick, Birmingham

WhiteAD 4022

OVERHEAD · TRAVELLERS · ELECTRIC GOLIATH

LOCOSTEAM

OVERHEAD

EST 1890

MARSHALL FLEMING CRANES

DELLBURN WORKS MOTHERWELL · SCOTLAND

Telephone: Motherwell 50 **Telegrams: "Dellburn" Motherwell**

LOCO STEAM · ELECTRIC GOLIATH · TRAVELLER

COUNT YOUR LUCKY STARS

BUT LET TRUMETER COUNT YOUR PRODUCTION

TRUMETER

FOR MEASURING & COUNTING

TRUMETER CO. LTD., MILLTOWN ST. RADCLIFFE, LANCS.

CW 2642/57

Portrait of a Welder . . .

At least that's how Dad sees him, because Dad's a welder himself and wants young John to follow that craft when he grows up.

So though he doesn't realise it now, young John is on to a good thing. He'll get the benefit of Dad's experience. And one thing he's sure to be told is to use S.I.F. products in every welding job he does. "There's nothing to beat 'em," says Dad. "There's thirty-one different rods in the S.I.F. range and each one is a winner."

You can find out about the S.I.F. range by writing to

SUFFOLK IRON FOUNDRY (1920) LTD., STOWMARKET, SUFFOLK

(ENR3)

NOTHING GETS PAST Hallprene

Hallprene

PATENT FLUID SEALS

PATENT No. 734525
U.S.A. PATENT No. 2,755,118
CANADIAN PATENT No. 547268

High pressure sealing over long periods is ensured by Hallprene Patent Fluid Seals. These seals overcome certain disadvantages of normal "U" type packing rings. Handling damage and inward collapse of the sealing lips is prevented by a soft, pliable synthetic rubber filling. Under pressure, this filling forces out the walls, ensuring a perfect seal.

Hallprene Patent Fluid seals are impervious to the action of hydraulic fluids.

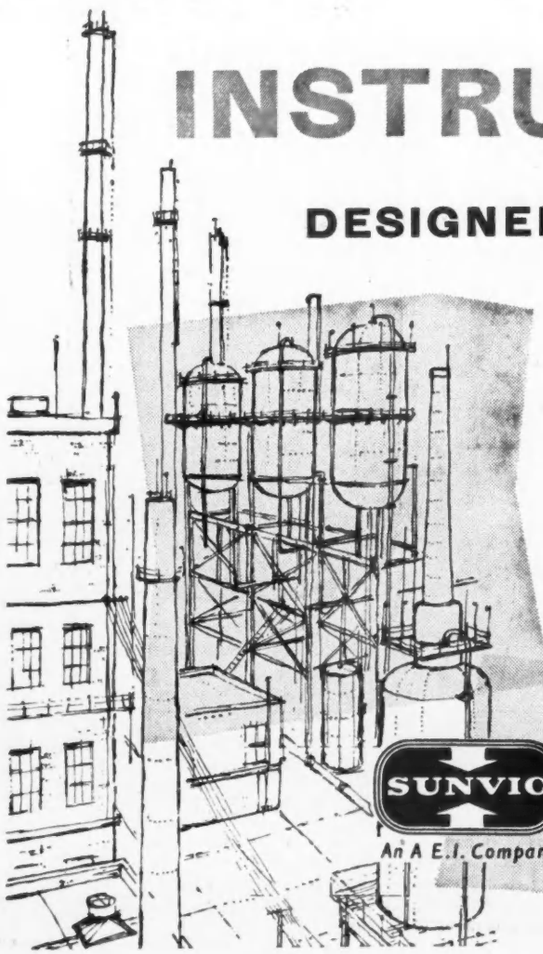
HALL & HALL LTD

OLDFIELD WORKS HAMPTON MIDDLESEX · Tel: Molesey 2180 (8 lines)

P309

INSTRUMENTATION

DESIGNED FOR BRITAIN'S INDUSTRY



Sunvic—an all-British company—pioneered the introduction of pneumatic force-balance instruments to this country. Now, in addition to supplying individual instruments, we will engineer complete pneumatic/electric process measurement and control systems, including data handling. Extensive research, design and engineering resources are available to industry at all times.

SUNVIC

An A.E.I. Company

Not only instruments but complete instrumentation

for integrated monitoring, control and data handling of nuclear reactors and industrial processes.

SC/71

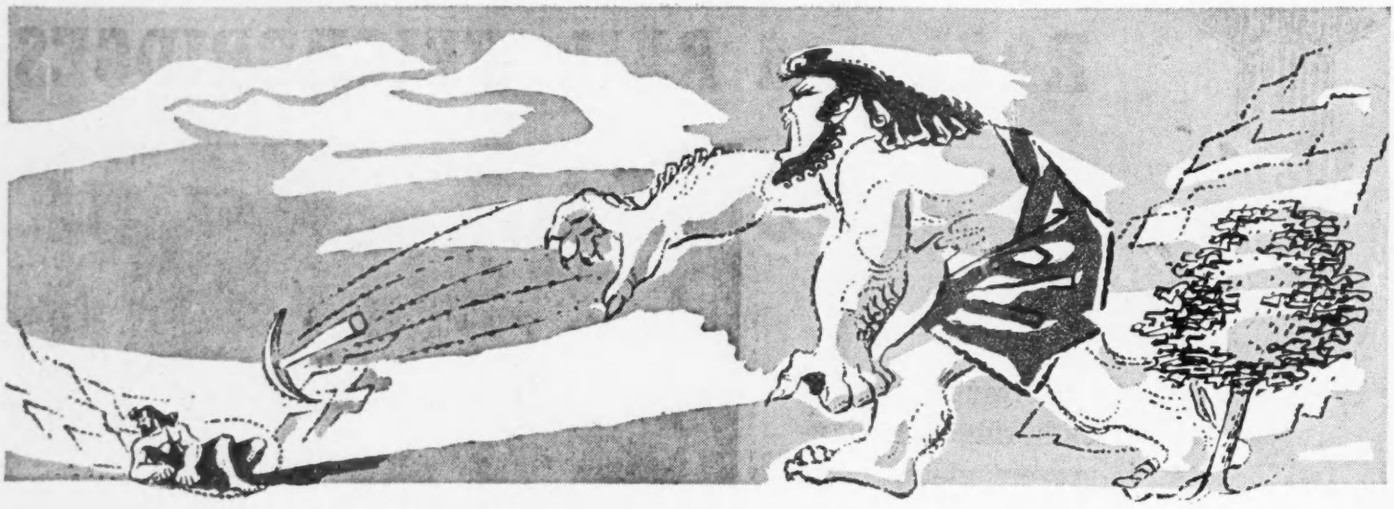
☐ Components and Electronic Instruments

☐ Nuclear Reactor Instrumentation

☐ Data Handling

☐ Pressure Control Instrumentation

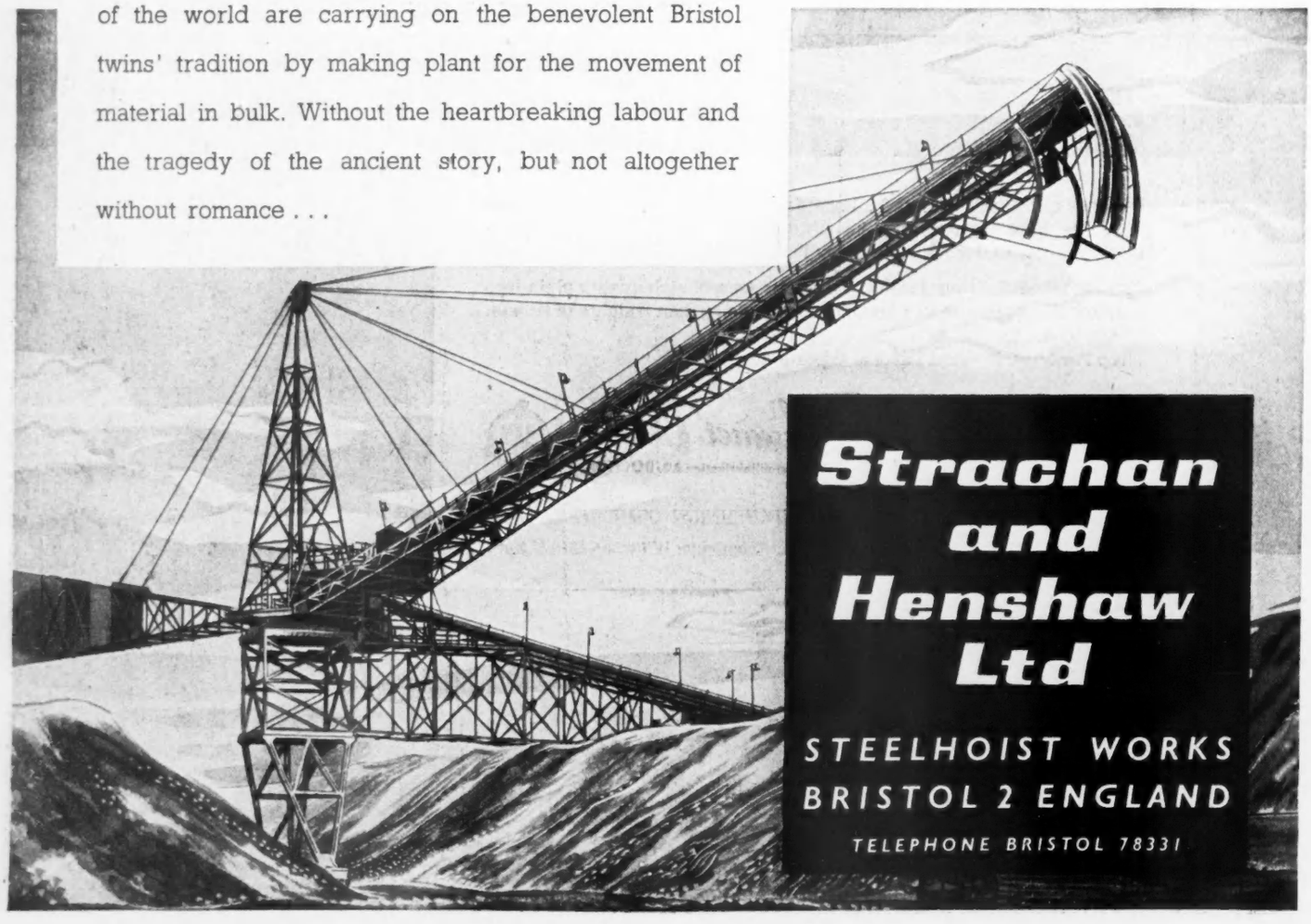
Just tick the applications that particularly concern you, pin this strip to your letterhead and post for further information to Sunvic Controls Ltd., P.O. Box 1, Harlow, Essex.



Giants of the West

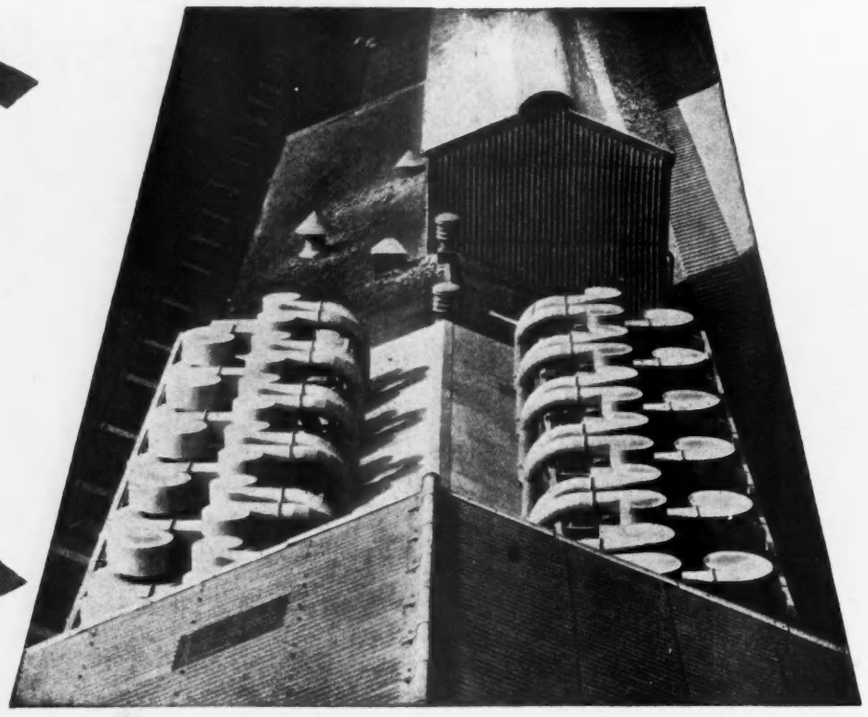
When Goram and his twin brother decided to dig Bristol an outlet to the sea they set about cutting the Avon Gorge — sharing a pickaxe which they tossed to each other at the end of each four-hour stint. Tragedy overtook poor Goram before the job was finished. Asleep in his vast chair hewn from the living rock (you can still see it at Blaise Castle) he failed to hear his brother's warning shout, and the pickaxe split his skull.

Giant Strachan & Henshaw installations in many parts of the world are carrying on the benevolent Bristol twins' tradition by making plant for the movement of material in bulk. Without the heartbreaking labour and the tragedy of the ancient story, but not altogether without romance . . .



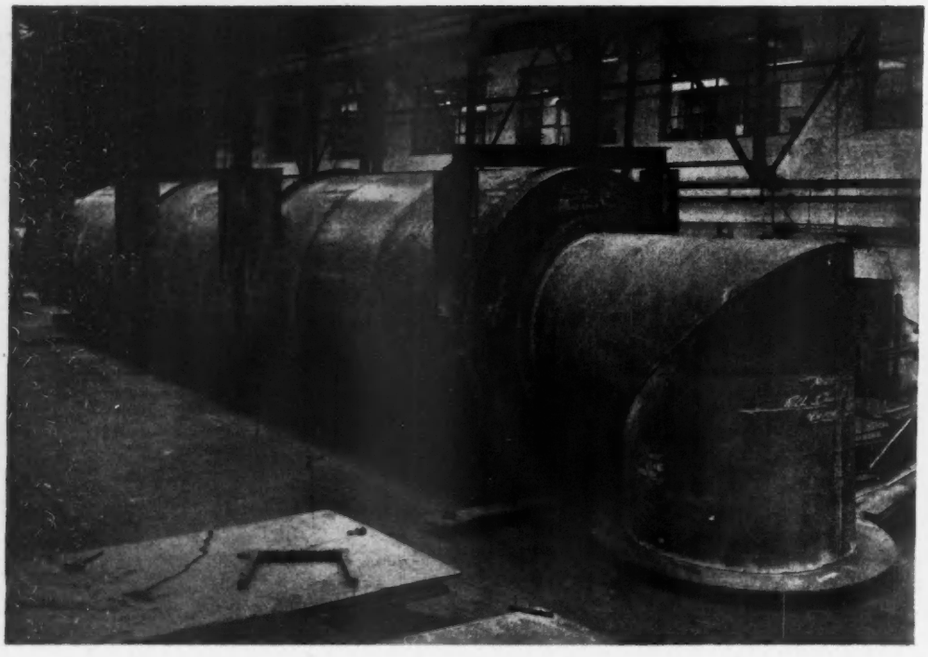
BRABY

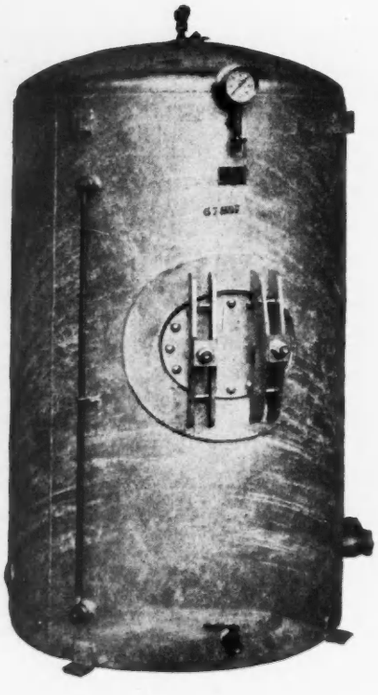
for Metal Plate and Sheet Metal Fabrications



Aero Jet Engine Test Cell Silencer. One of three sets for Royal Danish Air Force (Made by BRABY for their subsidiary company, Maxim Silencers Limited).

Mild Steel Plate Cyclones and Ducting supplied and erected at large Cattle Feed Mill in London.





Pressure Cylinder supplied to Mono Pumps Limited.

BRABY, with six factories located in widely separated parts of Great Britain, have, for more than 100 years, specialised in Metal Plate and Sheet Metal Work.

The technical knowledge and experience of our Staff and the employment of a labour force of skilled craftsmen, enable Braby to provide for Industry an efficient Metal Plate and Sheet Metal Work manufacturing service.

We welcome your enquiries.

ONE OF THE WIDE RANGE OF

BRABY

PRODUCTS

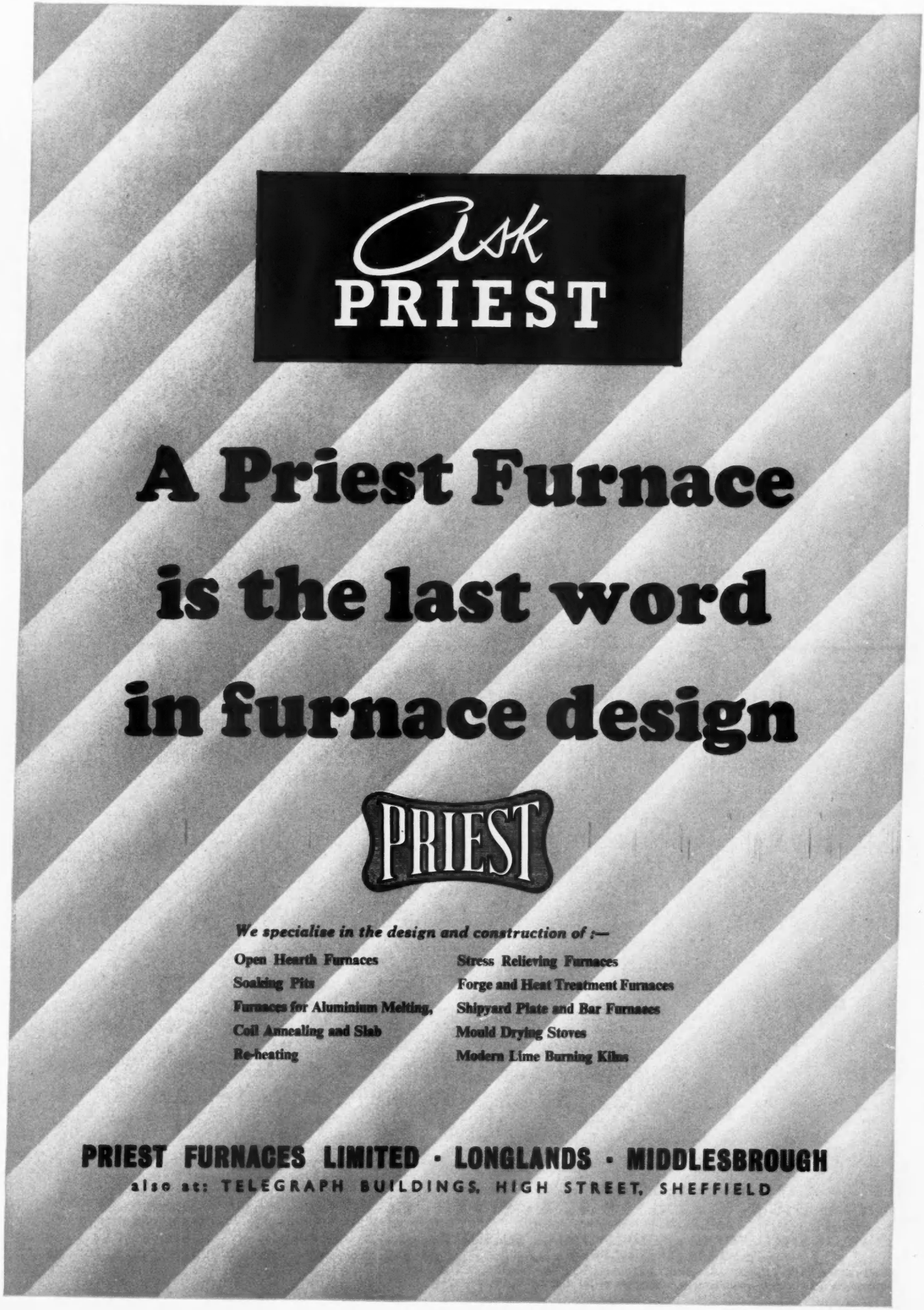
FREDERICK BRABY & COMPANY LIMITED

Head Office: 352-364 EUSTON ROAD, LONDON, N.W.1. TELEPHONE: EUSton 3456

FACTORIES AT: London Works, Thames Road, **Crayford**, Kent. TELEPHONE: Bexleyheath 7777
Havelock Works, Aintree, **Liverpool**, 10. TELEPHONE: Aintree 1721
Eclipse Works, Petershill Road, **Glasgow**, N. TELEPHONE: Springburn 5151
Ashton Gate Works, **Bristol**, 3. TELEPHONE: Bristol 64041. And **Falkirk**

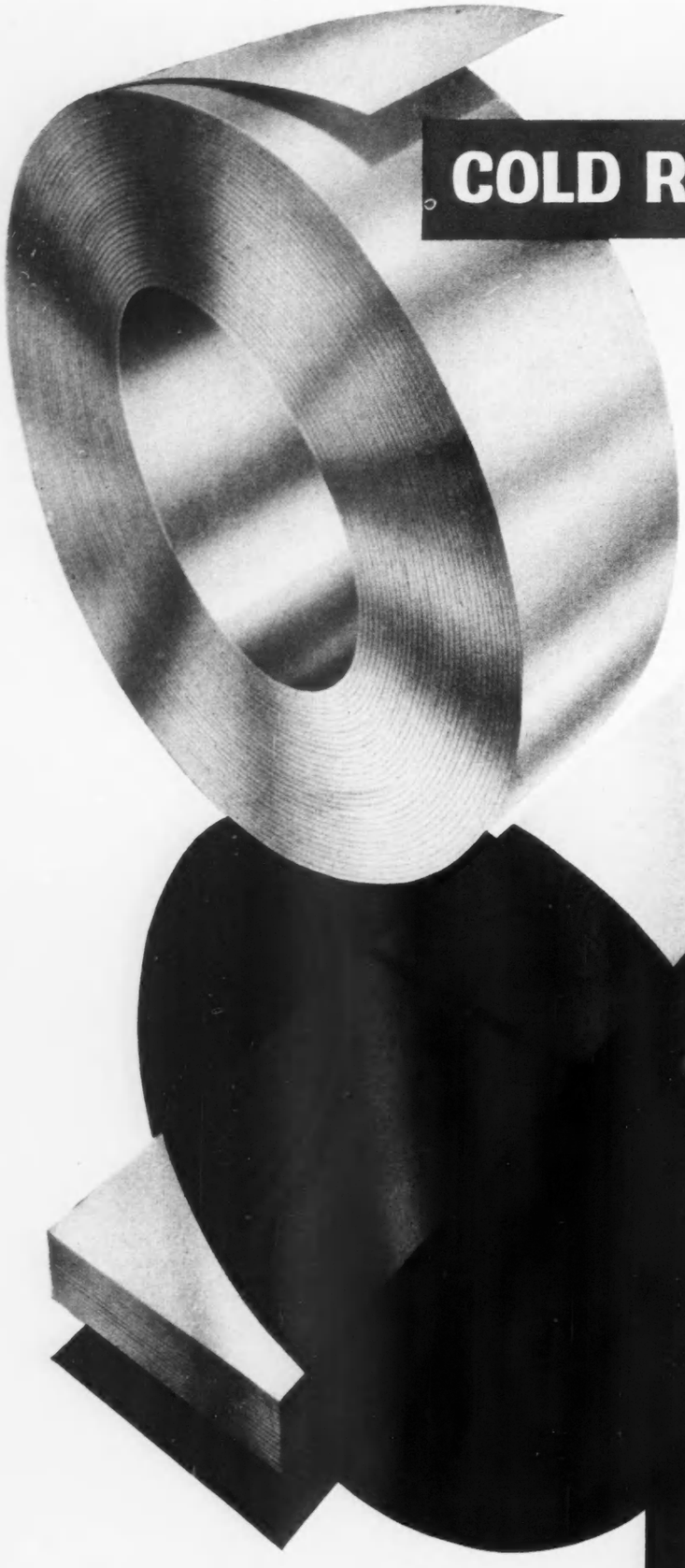
OTHER OFFICES: 110 Cannon Street, **London**, E.C.4 (Export). TELEPHONE: MANsion House 6034
Queen's Buildings, 10 Royal Avenue, **Belfast**. TELEPHONE: Belfast 26509
Palace Street, **Plymouth**. TELEPHONE: 62261

A.P. 90


Ask
PRIEST
A Priest Furnace
is the last word
in furnace design
PRIEST
We specialise in the design and construction of :—
Open Hearth Furnaces
Soaking Pits
Furnaces for Aluminium Melting,
Coil Annealing and Slab
Re-heating
Stress Relieving Furnaces
Forge and Heat Treatment Furnaces
Shipyard Plate and Bar Furnaces
Mould Drying Stoves
Modern Lime Burning Kilns
PRIEST FURNACES LIMITED · LONGLANDS · MIDDLESBROUGH
also at: TELEGRAPH BUILDINGS, HIGH STREET, SHEFFIELD

F132

M



COLD ROLLED STRIP

AND HOT ROLLED STRIP
(MILD, MEDIUM and HIGH CARBON),

BRIGHT STEEL BARS and WIRE,
'TRUBRITE' STAINLESS STEEL.

QUALITY CARRIES THE DAY

That's a good reason for having a word with LEE if the products you manufacture call for Steel Strip, Bars or Wire.

As it pays *us* to produce only materials of the highest quality and consistency, so it will pay *you* to use them because of the added prestige and sales they will bring you. *Write or 'phone now*

LEE

of Sheffield

ARTHUR LEE & SONS LIMITED
TRUBRITE STEEL WORKS · MEADOW HALL · SHEFFIELD
Telephone : Sheffield 387272
London Office : Stafford House, 40/43 Norfolk St., Strand, W.C.2. Tel : Temple Bar 7187/8
Birmingham Office : 191 Corporation St., Birmingham 4. Tel : Central 6801/2

C8514

'Doc'umentary evidence

'Doc', the personification of all our scientific brains, has at his disposal a library in which are filed nearly 20,000 references to previous experiments and their results in all fields of rubber technology.

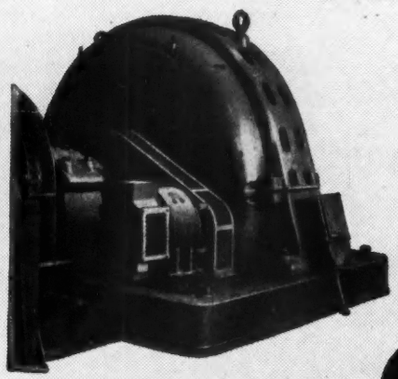
If he cannot there trace a ready-made answer to your problem, he is additionally blessed with scientific and technical resources plus experience which will rapidly provide a bespoke result.

JOHN BULL *Rubber*

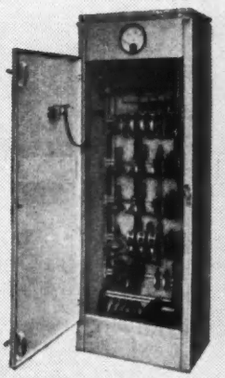
Solves your problems

JOHN BULL RUBBER CO. LTD. (INDUSTRIAL SALES DIVISION) LEICESTER • TELEPHONE 36531

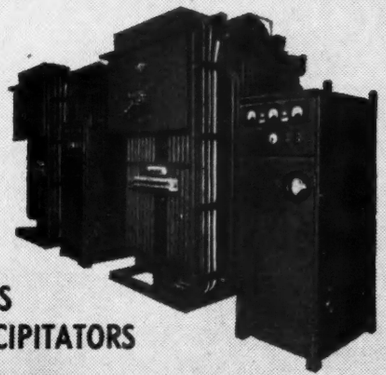
ROTATING MACHINES



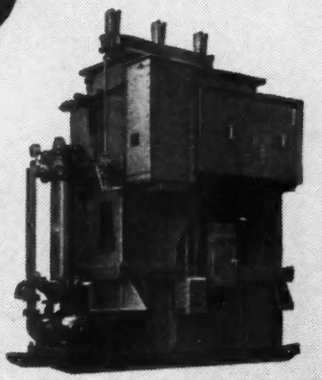
CONTACTOR TYPE SWITCH GEAR



ECC



RECTIFIERS FOR PRECIPITATORS

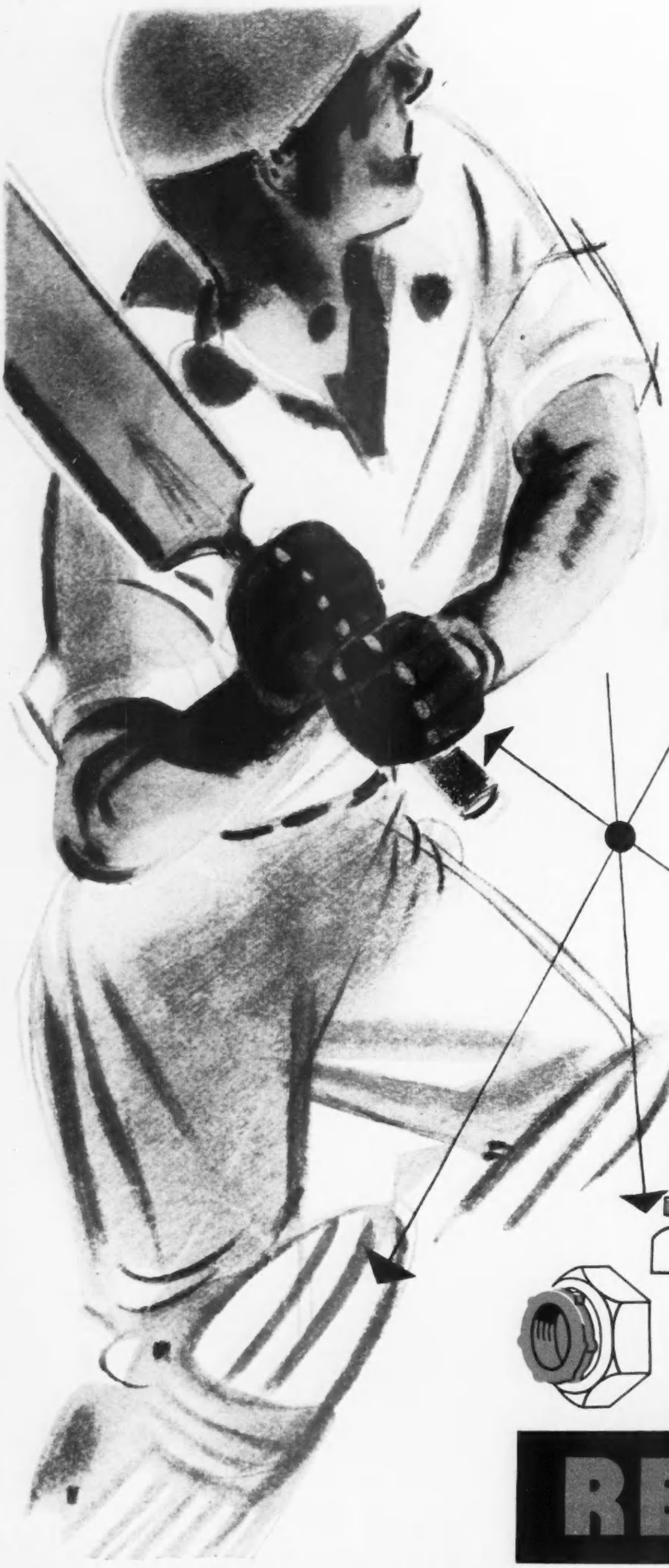


STATIC TRANSFORMERS

THE ELECTRIC CONSTRUCTION COMPANY LTD.

BUSHBURY ENGINEERING WORKS · WOLVERHAMPTON

3005

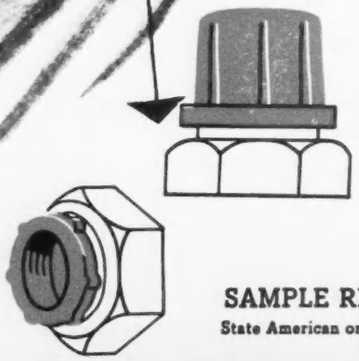


PROTECTION

plus something !

There can be few, if any, cricketers who have never missed a fast one and been thankful for the protection of gloves and pads.

Protection is the job of REDCAPS too—protection where it is most needed. But there is the little something extra. These neat, bright red caps improve the appearance and add a splash of colour wherever they are used—and they can be used in hundreds of ways.



USE REDCAPS *ON:-*

MACHINED COMPONENTS OF EVERY DESCRIPTION
CARBURETTORS • COUPLINGS
CONTROL • EQUIPMENT
FILTERS • FUEL INJECTION
COMPONENTS • HYDRAULIC
CYLINDERS & COMPONENTS
PUMPS • PRESSURE GAUGES &
INSTRUMENTS • PNEUMATIC
TOOLS • PIPES - BENDS -
ADAPTORS • REFRIGERATION
UNITS • ROTARY UNIONS
SCREW & PLUG GAUGES
SERVO EQUIPMENT • VALVES,
ETC., ETC.

SAMPLE REDCAPS SENT ON REQUEST

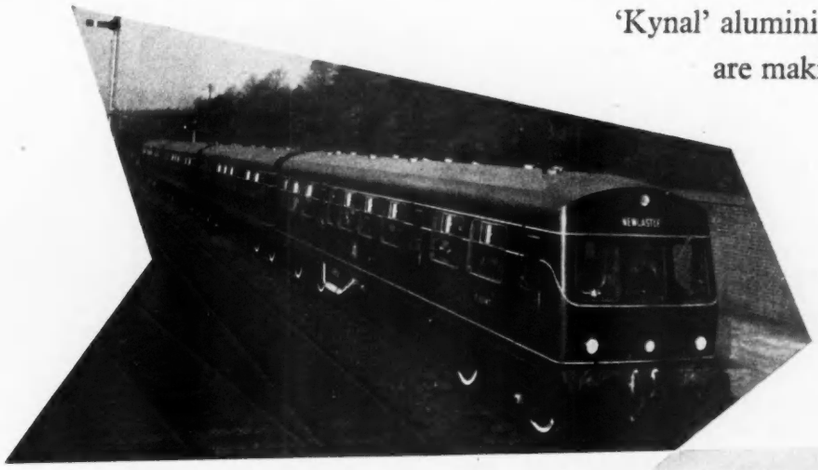
State American or B.S.P. threads or non-thread taper type.

REDCAPS

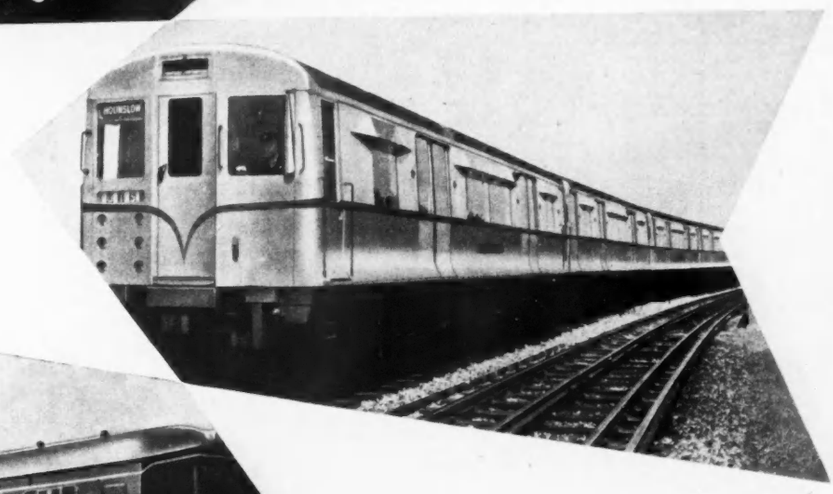
SUPER OIL SEALS & GASKETS LIMITED, FACTORY CENTRE, BIRMINGHAM, 30

A new look for BRITAIN'S RAILWAYS

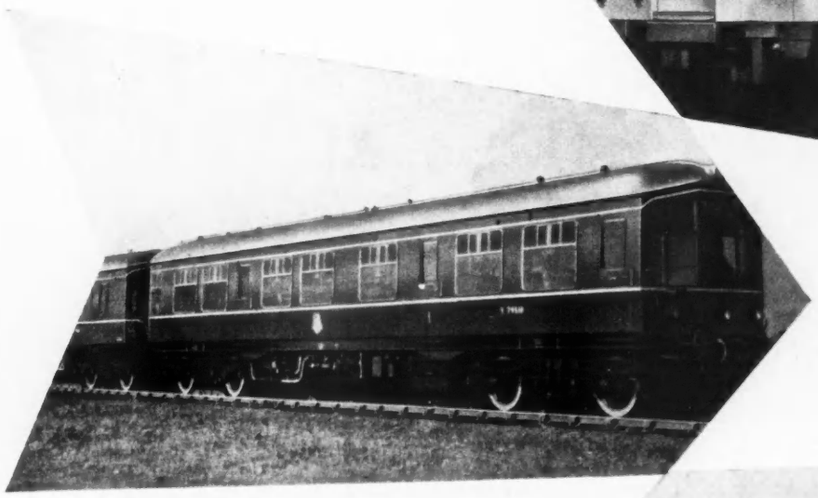
'Kynal' aluminium alloys, light, strong and long-lasting, are making a big contribution to the "new look" in British railway rolling stock.



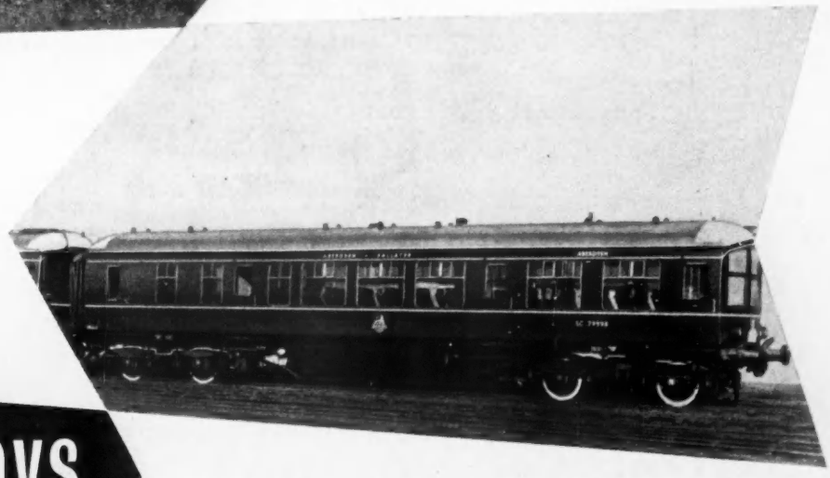
Steel and 'Kynal' aluminium alloys combine to good effect in 3-car and 4-car diesel units built by the Metropolitan-Cammell Carriage and Wagon Co. Ltd.



Designed and built by Metro-Cammell, 90 cars with aluminium alloy frames and bodies serve the London Transport District Line.



More than 200 all-aluminium multiple-unit diesel railcars, built by the British Transport Commission at their Derby Carriage and Wagon Works, are already in service.



Now in service on the Aberdeen/Ballater line — diesel-type train powered by battery-driven motors.

'KYNAL' Alloys

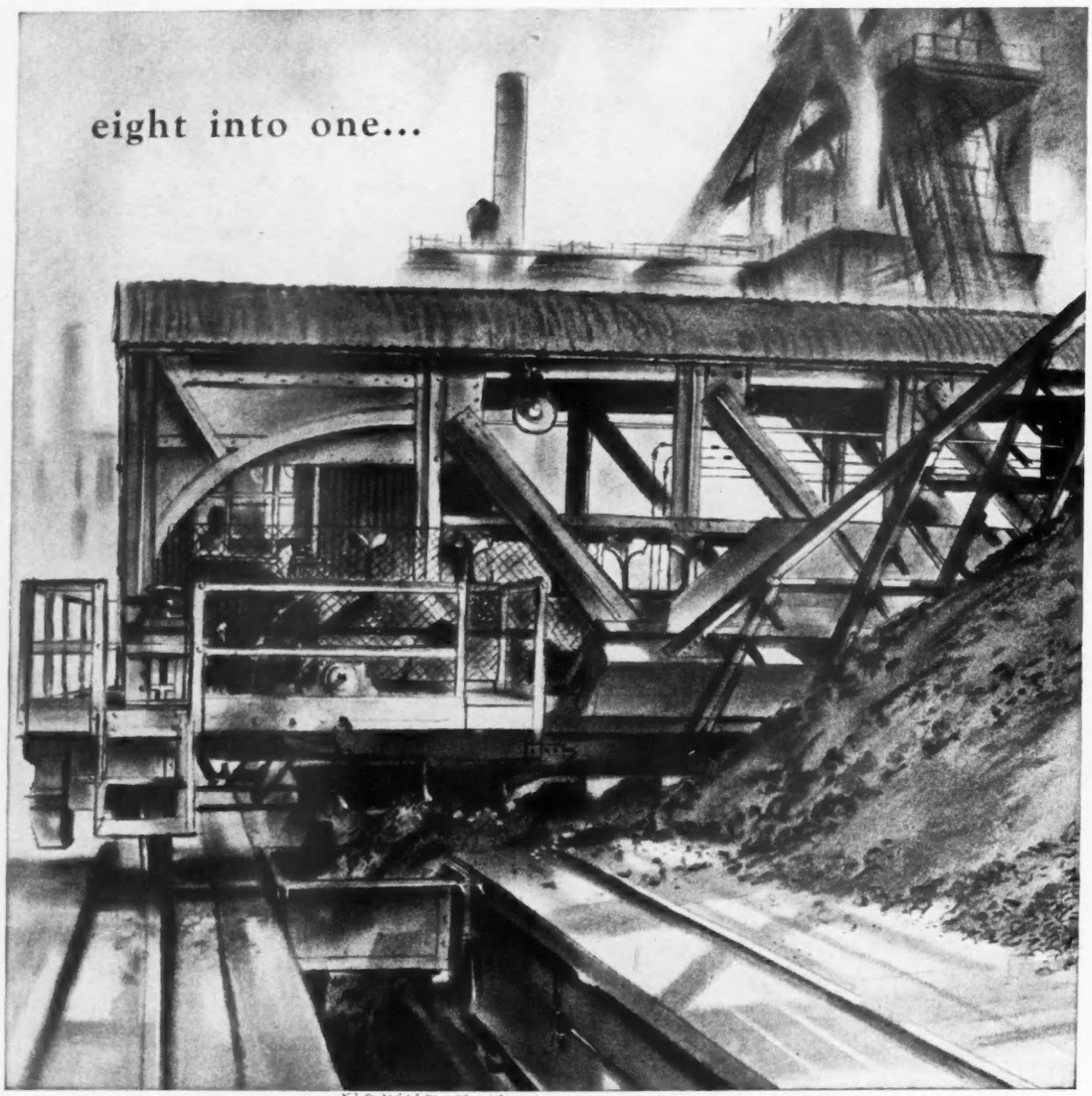
Made by specialists in aluminium for specialists in construction.

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1

ICI METALS DIVISION

KL 20.

N



Eight ores of varying quality are blended by this reclaimer into a product suitable for making iron. The Fraser & Chalmers Engineering Works of the G.E.C. in association with Hewitt-Robins possess a great deal of expert knowledge on materials handling which is available to interested companies.

G.E.C.

DESIGNERS AND MANUFACTURERS OF COMPLETE MATERIALS HANDLING PLANT

Fraser & Chalmers Engineering Works · Erith · Kent · England

MH281

STANLEY
INTEGRATORS

These integrators are instruments for the measurement of areas and moments of areas of plane figures, and can also be used in the determination of centres of gravity, volumes and moments of solids of revolution, etc.

Their application to many problems in Naval Architecture, Structural, Mechanical, Civil and Aeronautical Engineering greatly expedites the work while achieving a high order of accuracy—the precision of the instrument in most cases being greater than that with which the outline of the figure can be traced by a careful operator.

W. F. STANLEY & Co., Limited.

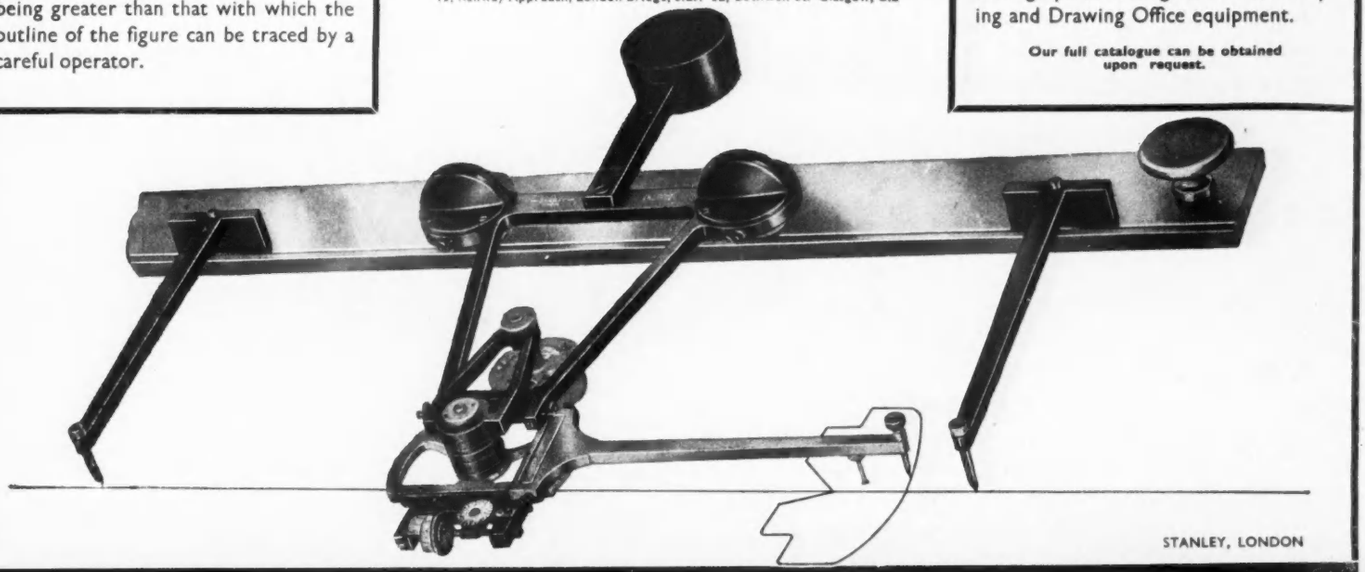
Head Office and Main Works:—
NEW ELTHAM - - LONDON, S.E.9
Telephone: Eltham 3836 *Telegrams: "Turnstile Souphone," London*
Showrooms:
79/80, High Holborn, London, W.C.1
Branches:
13, Railway Approach, London Bridge, S.E.1 52, Bothwell St. Glasgow, C.2

The illustration is that of our No. 1 model, and three models are available. Stanley Integrators can be supplied to give readings in either English (inch) or Metric units.

Send for illustrated literature giving full details.

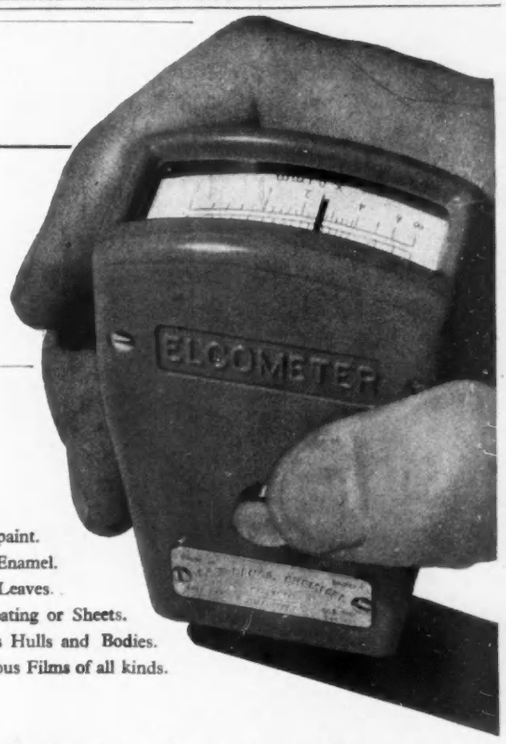
The "Stanley" range of instruments includes Theodolites, Levels, Harmonic Analysers, Integraphs, Planimeters, Pantographs, Drafting Machines, Surveying and Drawing Office equipment.

Our full catalogue can be obtained upon request.



STANLEY, LONDON

HAVE YOU A THICKNESS MEASURING PROBLEM?



Compact and easy to use, the Elcometer provides a simple economic method of measurement from one side without damage to surfaces. It gives split-second thickness readings of all non-magnetic coatings on ferrous bases with an accuracy of ± 5% ± .0001". Non-ferrous foils, sheetings etc., can also be measured if laid on a ferrous base. A wide range of models includes versions for gauging *Ferrite percentage content* of stainless steels and *graphitic corrosion penetration* in cast iron.

Measures:-
- Coats of paint.
- Vitreous Enamel.
- Tobacco Leaves.
- Plastic Coating or Sheets.
- Fibreglass Hulls and Bodies.
- Non-ferrous Films of all kinds.

THE ELCOMETER
THICKNESS GAUGE

EAST LANCASHIRE CHEMICAL COMPANY LIMITED
Fairfield 1 Manchester
Agents throughout the world.

For further information, send coupon for free booklet.
You are also invited to seek advice from our technical experts.

To East Lancashire Chemical Co. Ltd., Fairfield 1 Manchester.
Please send me a copy of booklet "The Elcometer Thickness Gauge".

Name .....

Address .....

..... *County* .....

BETTER TRY 600 FIRST !

FOR HYDRAULIC PRESSES

4000-ton U/S Press by **JOHN SHAW,** ram, 41in. diam. by 21in. stroke, table 5ft. square, daylight 24in., w.p. 3 tons per square inch, c/w pumps and control gear, ideal for die sinking.

1200-ton Double Acting by **FIELDING & PLATT,** down-stroking ram 26in. diam., 27in. stroke, upstroking ram 24in. diam., 24in. stroke, fixed and moving tables 5ft. diam., daylight 3ft. 9in., working pressure 5000 lbs. per square inch.

750-ton Downstroke by **T. H. & J. DANIELS,** moving cylinder type, ram 22in. diam., 3ft. stroke, tables 4ft. 9in. by 3ft. 7in., daylight 48in., w.p. 2 tons per square inch.

500-ton Downstroke by **HYDRAULIC ENGINEERING CO., CHESTER,** ram 18in. diam., 30in. stroke, tables 54in. by 42in., daylight 40in., w.p. 2 tons per square inch.

350-ton Downstroke by **BRADLEY & TURTON,** ram 15in. diam. by 24in. stroke, tables 39½in. by 37in., daylight 49in., w.p. 2 tons per square inch.

300-ton Downstroke by **M. B. WILD,** ram 20in. diam., 48in. stroke, tables 36in. by 28in., daylight 60in., w.p. 1 ton per square inch.

200-ton Overhung Downstroking by **HUGH SMITH,** ram 20¾in. diam., 20in. stroke, bed 54in. by 50in., table 32in. diam., gap 30in., daylight 31in., c/w jib crane.

150-ton Upstroke by **DEWRANCE,** ram 14in. diam. by 28in. stroke, tables 48in. diam., daylight 42in., w.p. 1 ton per square inch.

100-ton Overhung by **HENRY BERRY & CO.,** ram 8in. diam., 20in. stroke, daylight 30in., gap 19in., w.p. 2 tons per square inch.

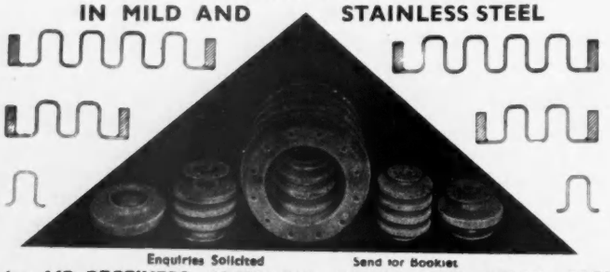
Horizontal Hydraulic Pipe Bending or Straightening Press by **FIELDING & PLATT,** ram 8in. diam., 20in. stroke, c/w pumps, control gear and heads and dies.

GEORGE COHEN
SONS AND COMPANY LIMITED

THE 600 GROUP OF COMPANIES

WOOD LANE, LONDON, W.12. *Tel. Shepherds Bush 2070*
STANNINGLEY, Nr. LEEDS. *Tel. Pudsey 2241*

ROSE'S EXPANSION PIECES
PRESSED STEEL BELLOWS TYPE
IN MILD AND STAINLESS STEEL



Enquiries Solicited Send for Booklet
also AIR RECEIVERS, CHIMNEYS, TANKS, PIPE WORK, PRESSURE CYLINDERS, AND FABRICATED STEEL PLATEWORK
BRITISH APPLIANCES MFG. CO., LTD.
DOLLY LANE, LEEDS, 9
Telephone : 30725-6 Telegrams : STRUCTURAL LEEDS 9

MAKERS OF GEARBOXES FOR 40 YEARS

ALBION ENGINEERING CO. LTD.
SAMPSON ROAD NORTH, BIRMINGHAM, 11
Telephone : Birmingham Victoria 4064

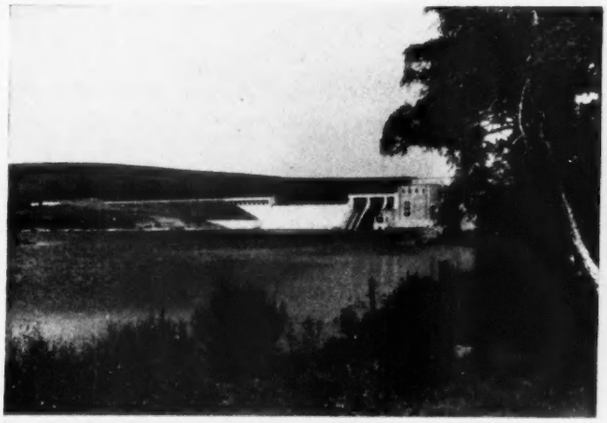
famous *for* forgings *of*

all descriptions in alloy and Carbon Steels
(all heat treatment facilities)

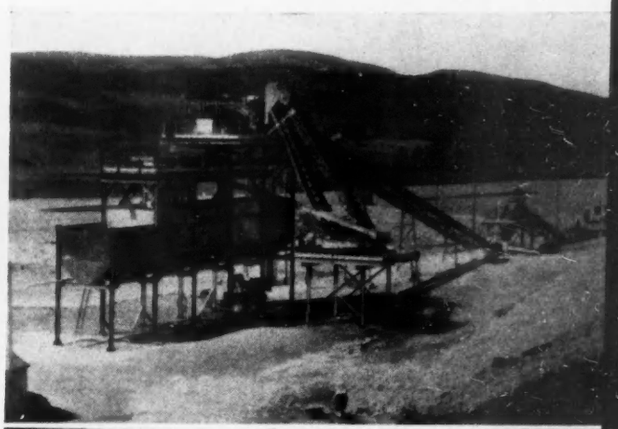
T. S. FORSTER & SONS LTD
FORGEMASTERS AND ENGINEERS
COPPERAS BANK FORGE, SUNDERLAND
TEL: 2876 'GRAMS 'FRAMES' S'LAND

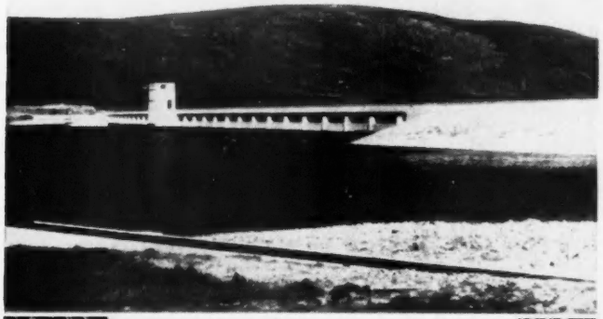
PARKER PLANT

helps to build the modern world

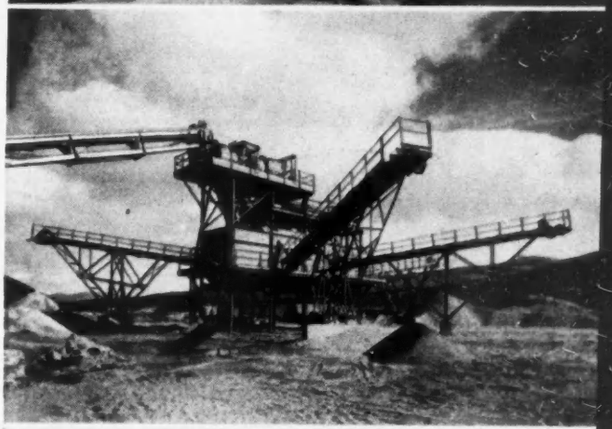


Loch Shin Hydro-Electric Dam, Scotland





Glascarnoch Hydro-Electric Dam, Scotland



Claerwen Dam, Wales

Glascarnoch Hydro-Electric Dam, Scotland. Galloway Power Scheme.
Haweswater Aqueduct Scheme. Claerwen Dam, Wales.
Castelo do Bode Hydro-Electric Dam, Portugal.
Loch Erne Hydro-Electric Dam, Ireland. Vaitarna Dam, India.
Mabubas Dam, Portuguese East Africa. Apapa Wharf, Lagos.
Loch Shin Hydro-Electric Dam, Scotland. Spelga Hydro-Electric Dam, Ireland.
Tai Lam Chung Dam, Hong Kong. Avon Dam, Devon.

Stands 38 & 39
GRAND HALL
PUBLIC WORKS EXHIBITION
OLYMPIA · NOVEMBER 10-15
See tomorrow's ideas today on the Parker Stand. Parkers' new developments are the most important exhibits of the show.

All Parker Plant is backed by the World-wide Parker Service Organisation

FREDERICK PARKER LIMITED - VIADUCT WORKS - LEICESTER **Phones: LEICESTER 62531 (7 lines)**
London: Stafford House, Norfolk St., W.C.2.

from WEAVER .... *to* USER

WOVEN WIRE CLOTH

FOR A **1001** DIFFERENT USES

IN ALL MESHES, GAUGES AND METALS

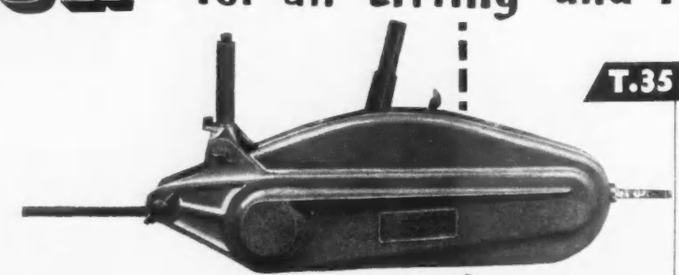
from STEEL to SILVER
TIN to TITANIUM
and PHOSPHOR BRONZE to PLATINUM

Any specification woven to your particular requirements.

206

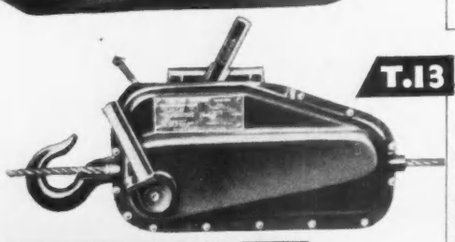
TIRFOR for all Lifting and Pulling

- Any height of lift
- Any length of pull



T.35

CAPACITY	LIFTING (SWL) 3 TONS PULLING 5 TONS
EFFORT	70/120 LBS.
WEIGHT	59 LBS.
SPEED	3/9 FT. PER MIN
SIZE	28¼" x 12½" x 5½"
MECH. ADV.	85 : 1



T.13

CAPACITY	LIFTING (SWL) 1 TON PULLING 30 CWT.
EFFORT	77 LBS.
WEIGHT	39 LBS.
SPEED	11½ FT. PER MIN
SIZE	24" x 12" x 6"
MECH. ADV.	43 : 1

TIRFOR LIMITED

DEPARTMENT TG12

27 BROOMGROVE ROAD, SHEFFIELD 10. *Telephone: 64436*

ONE OF THE SIMM ENGINEERING GROUP

Scotland: 'Phone Kirkintilloch 2468

London: 'Phone Tate 8772

S. Wales: 'Phone. Bridgend 1567

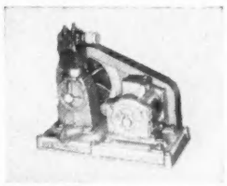
A·I·D equipment makes a world of difference

Spray-painting and compressor equipment designed to do a specific job does that job better, cheaper and faster. Recognising this, A. I. D. technicians have developed a range of equipment best suited to serve the many requirements of industry.

For instance, there is special equipment for spraying preservatives, special equipment for applying paint and fine finishes, special equipment for spraying sound-deadening materials and undercoatings. A.I.D. make everything behind the gun, too, from compressors right through to complete spray booth installations. Comprehensive service is always as near as the 'phone at your elbow. Literature and valuable technical assistance is yours for the asking, of course.

Model 50B. *Two stage semi-automatic stationary compressor — supplied complete with air receiver*

Model 2. *The famous spray gun that excels in every significant detail*



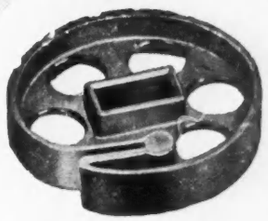
Model 10B. *Single stage semi-automatic stationary compressor — supplied complete with air receiver*

Model 7. *A spray gun of supreme achievement in precision, balance and control*

AIR INDUSTRIAL DEVELOPMENTS LTD
AIDSPRAY WORKS · SHENSTONE · NR. LICHFIELD · STAFFS · ENGLAND
Phone: Shenstone 341/5 Grams: Aidspray, Shenstone
CANADIAN OFFICE: 4 Lailey Crescent, Willowdale, Ontario. BA 1.2677

For DIE PRESSINGS
HOT BRASS & BRONZE

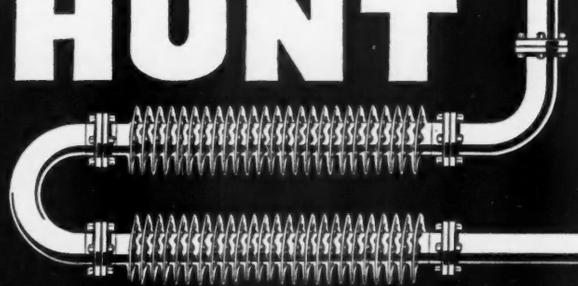
STAMPINGS
CAPSTAN & MACHINED WORK FROM STAMPINGS OR BAR



PLASTIC MOULDINGS
•
ZINC ALLOY PRESSURE DIE CASTINGS

BROOKES & ADAMS Limited
BARR ST. HOCKLEY
BIRMINGHAM 19
Phone : Northern 2903-4
Grams : Teleba B'ham.

HUNT



Gilled Tubes & Heaters
HUNT & MOSCROP LIMITED
P. O. Box No. 8 MIDDLETON · MANCHESTER

TRADE Smedley MARK
PAN GRINDING MILLS

REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN
Smedley Brothers. Ltd.
Belper. Derbyshire.
Telephone: Belper 12

A FOUR YEAR RUN...

Photograph by courtesy of Celotex Ltd.

This drying conveyor illustrates one of the many applications of MORGANITE CARBON BEARINGS where carbon is the most suitable material. Thousands of tons of Wallboard pass over these rollers every year—4,000 MORGANITE CARBON BEARINGS undergo severe duty to make this possible—each carries a load of about 30 pounds and is subjected to temperatures up to 650°F in a very dry and dusty atmosphere. In spite of these arduous conditions replacement is only necessary after 4 years.

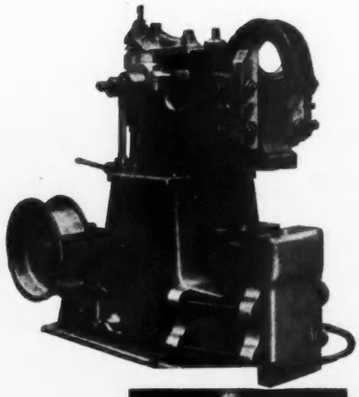
MORGANITE CARBON BEARINGS solved the problem for CELOTEX —perhaps they will solve your's today. Please write or phone for leaflet SD.63 or ask for one of our Technical Advisers to call.

MORGANITE CARBON BEARINGS withstand high temperatures; will run in liquids; resist chemical atmospheres and corrosive conditions; need no lubrication; and useful for inaccessible positions; are non-contaminating and eliminate maintenance.

MORGANITE BEARINGS

THE MORGAN CRUCIBLE COMPANY LIMITED, BATTERSEA CHURCH ROAD, LONDON, S.W.11. **Telephone: BATtersea 8822**

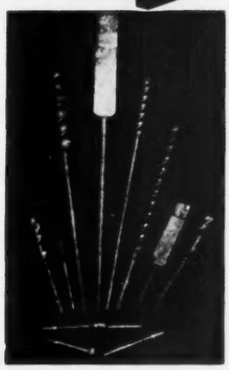
C64a



MORE POWER

TO YOUR ELBOW !

- 275/300 blows per minute.
- Average size of work 1¼" bar.
- Adjustable stroke and guides.
- Rubber cushioned overhead motion.
- Loose Anvil Block.
- Separate motor stand available.



A typical example of the type of work accomplished on this machine.

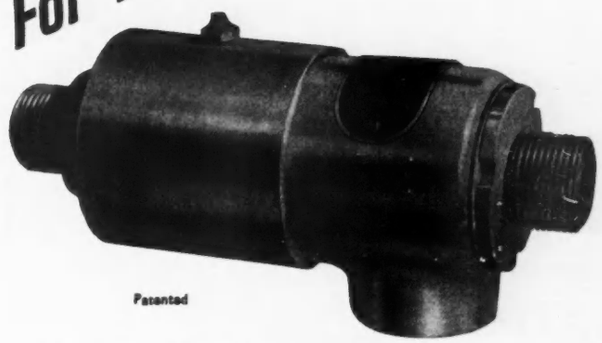
For High Speed Precision Forging— the Model '100' POWER HAMMER.

SAMUEL JELLYMAN LTD

CANNOCK FOUNDRY & ENGINEERING WORKS
CANNOCK • STAFFS

TELEPHONE— TELEGRAMS CANNOCK 2188

Consult FILTON For Rotary Unions—



Patented

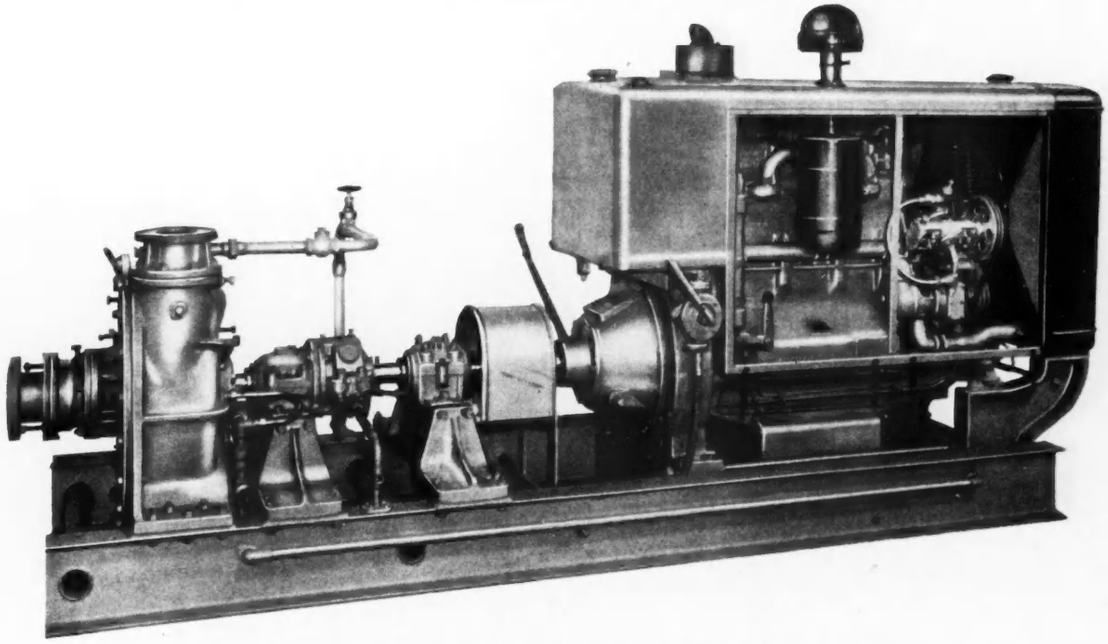
For use on all types of Rotary and Semi-Rotary Machines for Leakproof Fluid Transfer
Standard Sizes ¼"—3" B.S.P.
Special Sizes & Designs up to 6" B.S.P.

As used by leading Engineering Companies and Government Departments

FILTON LIMITED

FILTON LTD. CLAPHAM STREET, LEAMINGTON SPA, WARWICKSHIRE
Telephone: LEAMINGTON SPA 8111/2

GRAVEL PUMPS



4½/5" Centrifugal Sand and Gravel Pump with Diesel Engine Drive.

EASTON & JOHNSON LTD. · TAUNTON, ENGLAND

TELEPHONE 3146 GRAMS: EASTWALD, TAUNTON

THE WORLD'S GREATEST BOOKSHOP

FOYLES
FOR BOOKS

FAMED CENTRE FOR
Technical Books

"That's what I call quick service—I telephoned Foyles at 10 a.m. and the book (although it was out-of-print) reached me by the next morning's post."

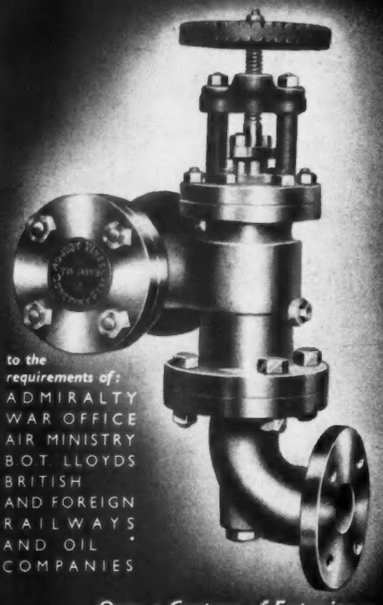
—A Customer's Letter

STOCK OF OVER ⅓ MILLION VOLUMES
119-125 CHARING CROSS ROAD, LONDON, W.C.2
Gerrard 5660 (20 lines) ★ Open 9—6 (including Saturdays)
Two minutes from Tottenham Court Road Station

HAMMERED OR HYDRAULIC PRESSED
FORGINGS
IN STEEL
BLACK OR MACHINED
TO 24 TONS
INCE FORGE CO. WIGAN
PARKS FORGE LTD
PROPRIETORS

SIRRON
Diesel Engines
Main Propelling Diesel Engines in powers up to
1,200 H.P.
THE NEWBURY DIESEL CO. LTD.
NEWBURY, BERKS

"HYSON" VALVES and BOILER MOUNTINGS

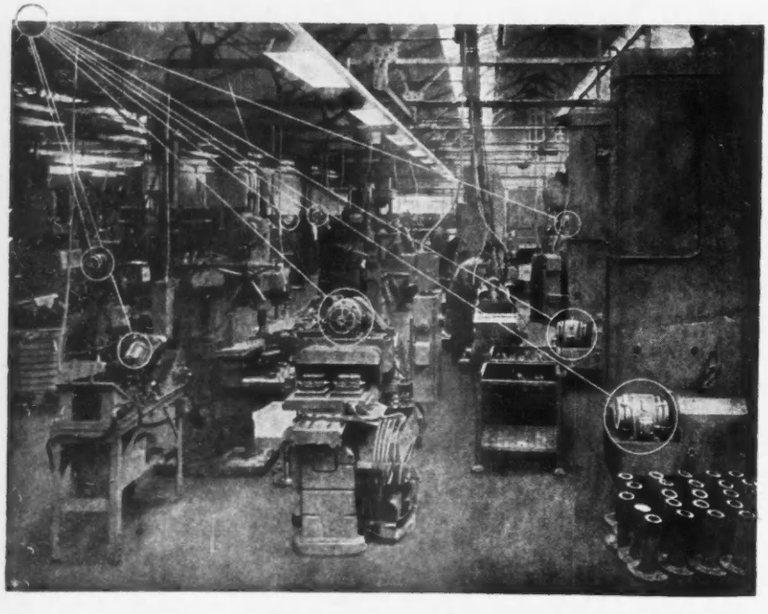


to the requirements of:
ADMIRALTY
WAR OFFICE
AIR MINISTRY
B.O.T.
LLOYDS
BRITISH AND FOREIGN RAILWAYS
AND OIL COMPANIES

Over a Century of Experience
SMITH BROS. & CO. (HYSON) LTD.
HYSON GREEN VALVE WORKS
NOTTINGHAM, ENGLAND
Telegrams: "HYSON" Telephone: NOTTINGHAM 77234

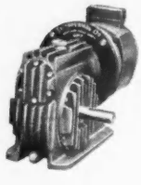
POWER - - - - - - - - - -

WHEN... WHERE and HOW YOU NEED IT!



with
GEARED MOTOR UNITS
FROM STOCK

Since 1862 S. E. Opperman Ltd., have gained unique practical experience in the manufacture of a wide range of Geared Motor Units covering a vast field of uses and applications. First class design, top grade materials and fine workmanship have continuously been employed, giving high efficiency, smooth and cool running and long life. Geared Motor Units are available from stock fitted with electric motors made to the latest specification by Britain's leading motor manufacturers.

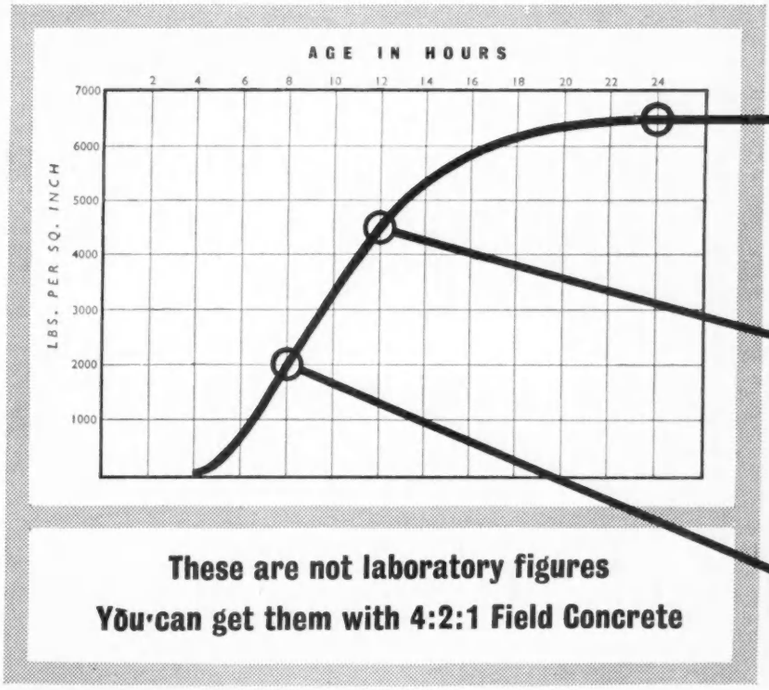


S. E. OPPERMAN LTD.
BOREHAM WOOD, HERTS. Tel. ELSTREE 2021

Concrete IN HOURS – not days

FOR GREATEST STRENGTH AT HIGHEST SPEED

YOU MUST USE FONDU! Here's why



6,500 LBS PER SQ. INCH AT 24 HOURS

4,500 LBS PER SQ. INCH AT 12 HOURS

2,000 LBS PER SQ. INCH AT 8 HOURS

These are not laboratory figures
You can get them with 4:2:1 Field Concrete

CIMENT FONDU
Regd Trade Mark
ALUMINOUS CEMENT
The Cement for Industry

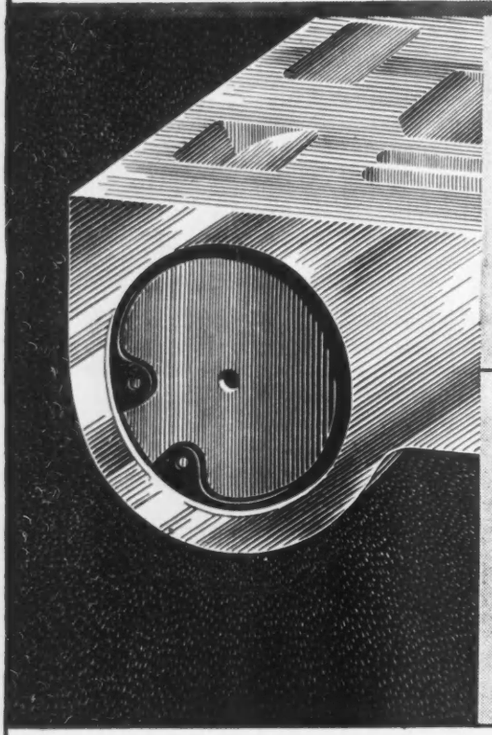
Think what these figures can mean to you in saving time and labour
No other type of cement can equal them
Always keep a stock of Fondu handy for urgent jobs

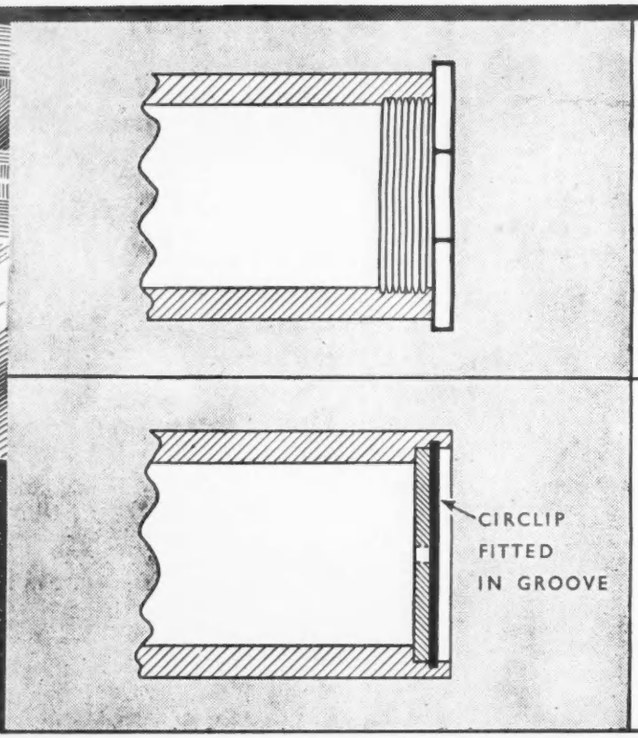
Write today for further particulars and latest literature.

LAFARGE ALUMINOUS CEMENT CO. LTD.
73, BROOK STREET, LONDON, W.1. TEL: MAYFAIR 8546

AP/75

The logical advance in Retaining





OLD WAY

This fluid seal involved internal threading of the tube, which was sealed with an expensive cap-nut. The assembly was laborious and spanners were needed.

THE SALTER WAY

The tube is recessed and then simply grooved with the SALTER Grooving Tool. A Circlip is snapped into position and secures the fluid retaining plate with positive, vibration-free locking. When necessary the Circlip can be removed quickly and easily.

save material—reduce assembly time — cut costs

When it's a question of assembling components in any engineering field, Salter Retainers are the answer. They replace nuts and bolts, screws, cotter pins, and eliminate expensive threading and machining operations. A large standard range is at your immediate disposal, and we should welcome the opportunity to assist in developing special retainers to solve your problems.

SMITHFIELD SHOW Dec. 8 - 12
STAND No. 239

Send for the Salter Retainer catalogue — no designer is complete without it.

NEATER — MORE POSITIVE — PERMANENT RETAINING

SALTER "TRUARC" Regd. Trade Mark

Circlips Fasteners Retainers Fixes

Geo. Salter & Co. Ltd., West Bromwich · Spring Specialists since 1760

H-W.448

Now available for general industrial purposes

Thorn Plasteck panel lighting

Thorn Plasteck trans-illuminated panels fully satisfy the extreme standards of efficiency and flexibility demanded by the aircraft industry and are now specified as standard equipment by the majority of Britain's aircraft constructors. For wider engineering and industrial applications, Thorn Plasteck will be found unexcelled in providing "even" illumination for instrument and control panels from the simplest individual unit to the most elaborate of large consoles.

Thorn Plasteck Panel illumination . . .

is rheostat dimmer controlled

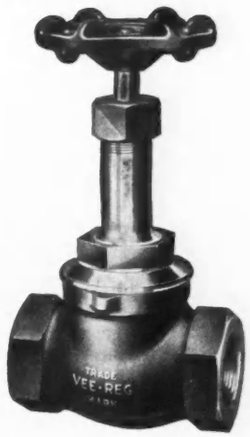
ensures consistent legibility in daylight, dusk or complete darkness

does not impair night vision.

Plasteck consists of a thick sheet of acrylic plastic faced on both surfaces with translucent white plastic. Black or grey copolymer is added to the top surface and the whole bonded together. Inscriptions and dials are engraved through to the white layer and are clearly legible in daylight. Strategically located lampholders provide night illumination. Special red filters are incorporated and the red light is transmitted through the acrylic plastic to back illuminate the engraving. Instruments are illuminated by facets angled in the Plasteck surrounding the dial.

Thorn

THORN ELECTRICAL INDUSTRIES LIMITED
Aircraft Components & Connector Division
Great Cambridge Road Enfield Middlesex
Tel: ENFIELD 5353.



VEE - REG

Regulating/Stop

GLOBE VALVES

FITTED WITH 'V' PORTED STAINLESS STEEL CLACK & SEAT

• • •

In Bronze & Steel for Pressures up to 900 P.S.I. and 800° F.

• • •

WRITE FOR CATALOGUE TO :—

THE BRITISH STEAM SPECIALTIES LTD.
FLEET STREET
LEICESTER

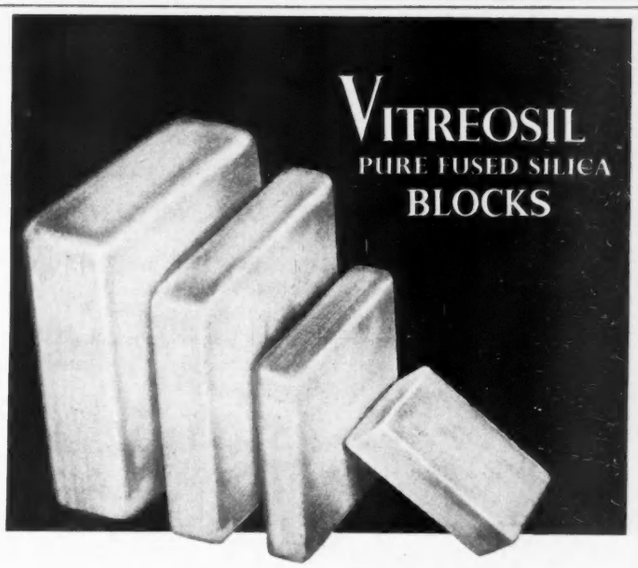
STEEL FRAME BUILDINGS
OF EVERY DESCRIPTION

Factories, Sheds, Mill Buildings, Bungalows, Etc., Etc.

SPECIALITIES: Pit Headgear, Pumping Stations, Power Stations

Bridgework and Riveted Work of all descriptions

BROWNLIE & MURRAY LTD.
POSSIL IRONWORKS, POSSIL PARK, GLASGOW
LONDON: 32 QUEEN VICTORIA ST., E.C.4



REMEMBER POPPY DAY

Vitreosil Pure Fused Silica Blocks are now available up to 36″×18″×18″; larger sizes are under development.

Present applications are for special glass melting furnaces and constructions where freedom from contamination and stability at high temperatures are desired.

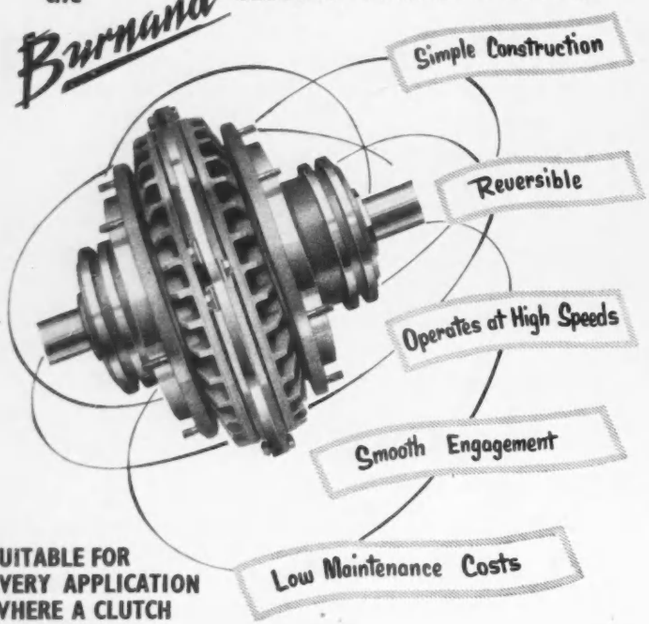
Your enquiries will be given prompt attention.

TSL SERVICE TO INDUSTRY

THE THERMAL SYNDICATE LTD.,
P.O. Box No. 6. WALLSEND, NORTHUMBERLAND.
Telephone : Wallsend 6-3242
LONDON: 12-14, OLD PYE ST., WESTMINSTER, S.W.1
Telephone : ABBey 5469

the Modern Touch–

the **Burnand** ELECTRO - MAGNETIC CLUTCH

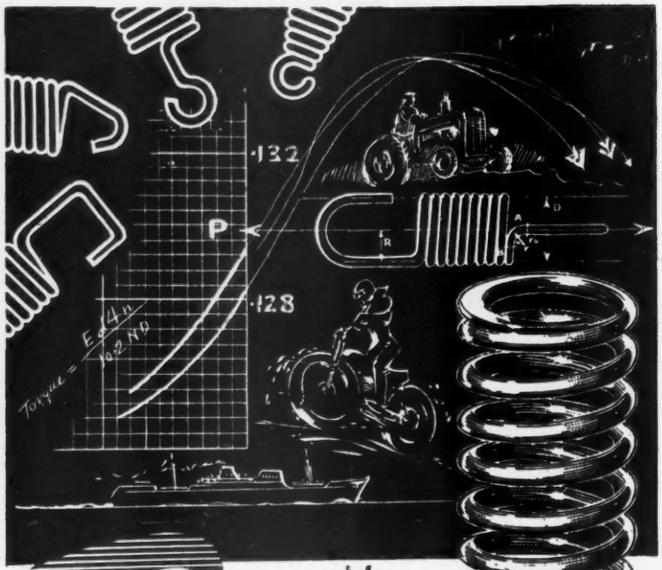


SUITABLE FOR EVERY APPLICATION WHERE A CLUTCH IS REQUIRED

We will be pleased to supply you with further information on this electro-magnetic clutch or, to arrange for a technical representative to call.

Burnand

W.E. BURNAND & SON, LTD., 66-106, SHOREHAM ST., SHEFFIELD 1, ENGLAND.



Ratcliffe

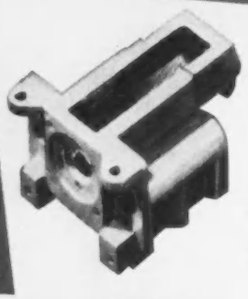
SPRINGS

F. S. RATCLIFFE (ROCHDALE) LIMITED,

CRAWFORD SPRING WORKS, NORMAN ROAD, ROCHDALE

'Phone: Rochdale 4692/3. 'Grams: Recoil, Rochdale. CW5188

Cast - well & true

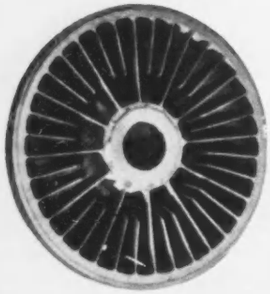


PRESSURE DIE CASTINGS

Our large capacity battery of Pressure die casting machines delivers large quantities for continuous supply, including these Frames in Zinc-based Alloy B.S.1004A.

GREY IRON CASTINGS

Our highly mechanised Iron foundries can supply castings up to 500 lbs. weight from the five mechanised units or up to 5 tons from the floor casting foundry.



GRAVITY DIE CASTING

Examples of Aluminium Alloy Castings supplied on regular delivery ON TIME—Fluid Flywheel Rear Casing in L.M.23.

ALUMINIUM SAND CASTINGS

The Aluminium Foundries also include mechanised and jobbing sections and many intricate castings, such as these Cylinder Heads in L.M.4 Aluminium Alloy, are produced in quantity.

Please write for details

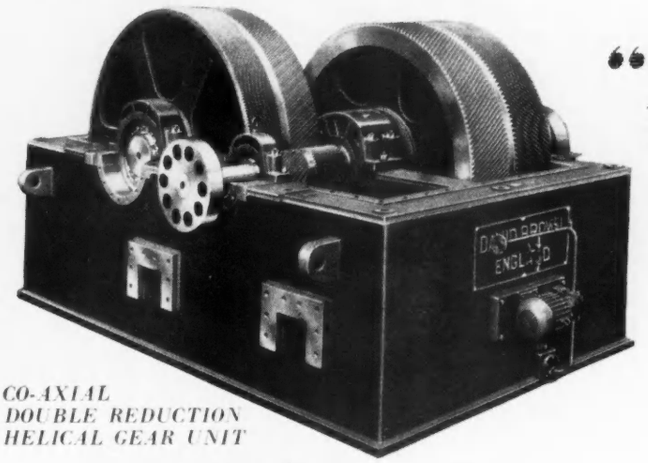
West Yorkshire Foundries Ltd.

SAYNER LANE, LEEDS 10 Telephone: LEEDS 29466

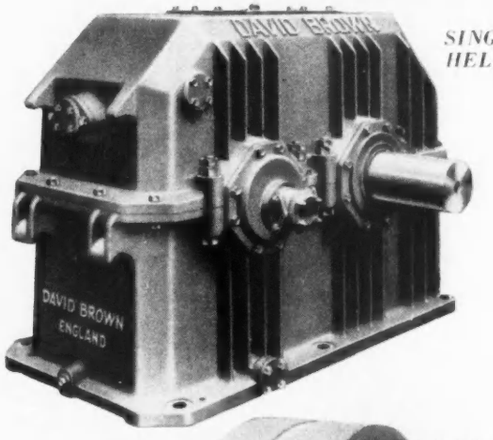
London Office:
HANOVER HOUSE, HANOVER SQ. W.1. Telephone: MAYfair 8561

DAVID BROWN

"the people who know!"



CO-AXIAL DOUBLE REDUCTION HELICAL GEAR UNIT



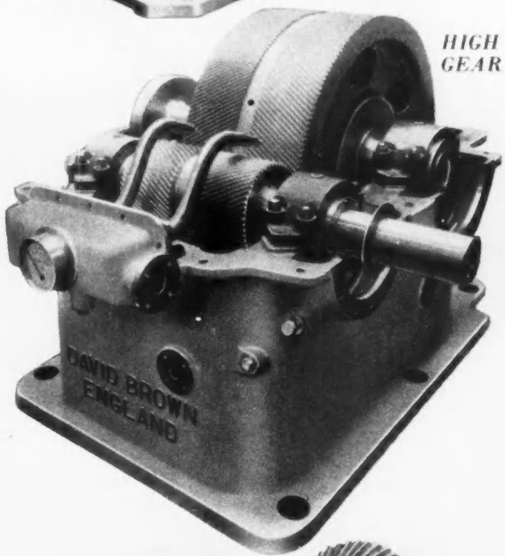
SINGLE REDUCTION HELICAL GEAR

The many thousands of David Brown gear units, supplied for all types of major industrial drives, have built up an unrivalled reputation for reliability.

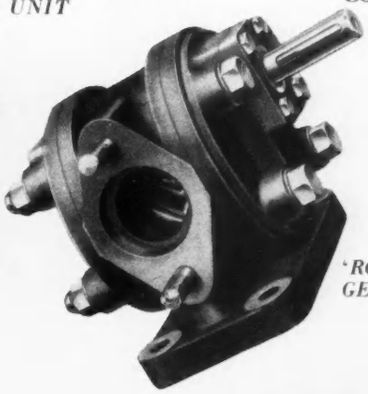
Intimate knowledge of industrial requirements, backed by well over 50 years experience, has led to the development of extensive ranges of standard units, carefully selected to cover every need.

Consult "the people who know" and make certain you get the right unit for your drive.

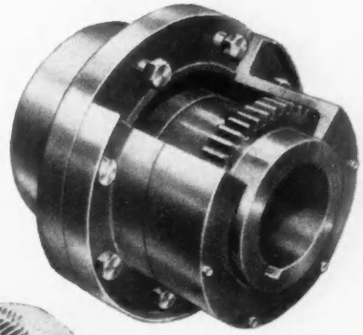
THE
DAVID BROWN
CORPORATION (SALES) LIMITED
GENERAL GEAR DIVISION
PARK WORKS HUDDERSFIELD



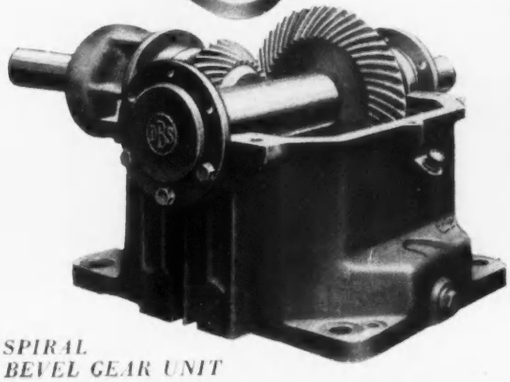
HIGH SPEED TURBINE GEAR UNIT



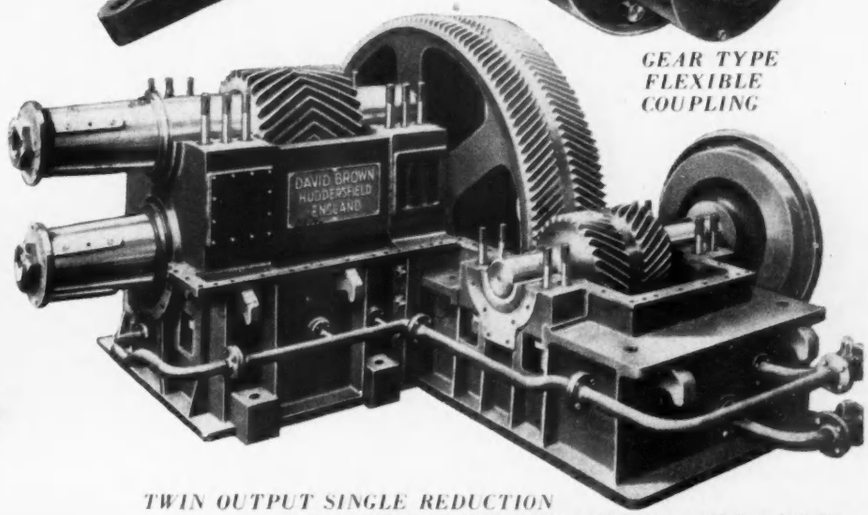
'ROLOID' GEAR PUMP



GEAR TYPE FLEXIBLE COUPLING



SPIRAL BEVEL GEAR UNIT



TWIN OUTPUT SINGLE REDUCTION HELICAL GEAR UNIT FOR ROLLING MILL DRIVES

A New Tool Steel

OSBORN

MUSHET SPECIAL 'V.G.'

HIGH-SPEED STEEL

Mushet Special "VG" high-speed steel is the very latest development of tool steels in the United Kingdom, by Samuel Osborn & Co., Limited. Remarkable results under production conditions are assured, far in advance of other tool steels in this category.

Stocks of lathe tools, planer tools and toolholder bits, in this steel, are available in standard sizes.

IMPROVED PERFORMANCE FROM MACHINE TOOLS

If you use centre lathes, capstans, automatics, combinations, planers, shapers, boring mills, etc., these tools will :

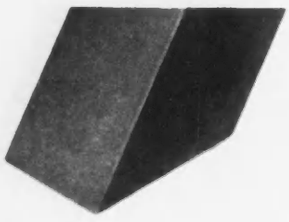
★ **CUT FASTER**

★ **LAST LONGER**

★ **MACHINE TOUGHER MATERIALS**
—including Nimonic alloys

★ **REDUCE PRODUCTION COSTS**

• *ALSO AVAILABLE IN BAR AND BLANK FORM*



ANOTHER OSBORN SUPER PRODUCT

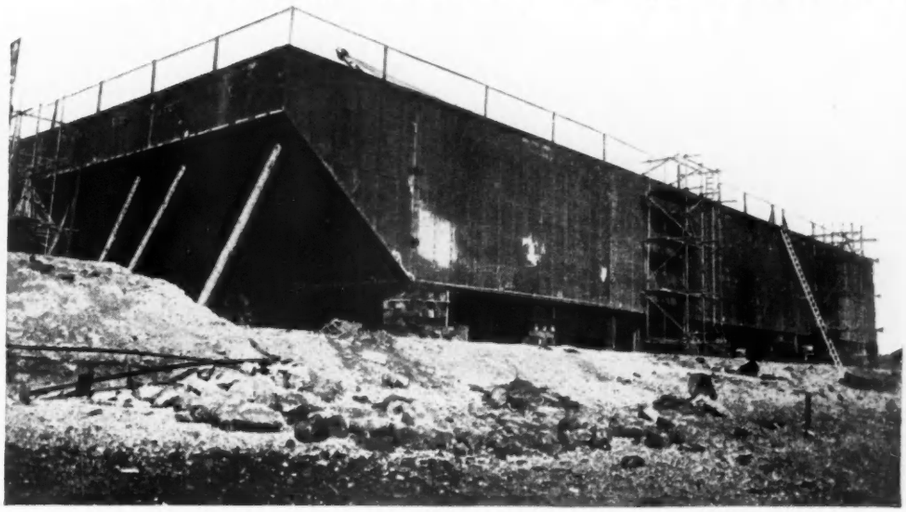
★ **Comprehensive stocks constantly maintained**

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD

FINE STEEL MAKERS · STEEL FOUNDERS · ENGINEERS' TOOLMAKERS.

FIRST IN THE FIELD—AND STILL IN THE LEAD



The Pre-fabricated Drilling Platform under construction, showing the bow end.

Once again...

LINCOLNWELD SUBMERGED ARC WELDING UNITS ARE CHOSEN IN PREFERENCE TO ALL OTHERS

The first of its kind to be built in Great Britain, the 4,800 ton marine oil drilling platform being constructed at Southampton by STEEL STRUCTURES LTD., in association with John Howard & Co. Ltd., of London, and the De Long Corporation of New York is extensively LINCOLNWELDED.

LINCOLNWELD Fully Automatic Submerged Arc Welding Units using Lincolnweld Wire and Flux have been extensively employed for the fabrication of the platform, the all-welded hull (200 ft. long, 106 ft. wide and 16 ft. deep), the Caisson Shells and the Jacking Bars.

Lincoln Improved Fleetweld 5 electrodes were used for the hand-welding of the root runs on the Caisson Shells and Lincoln Jetweld Iron powder electrodes for the manual welds on the Jacking Bars.

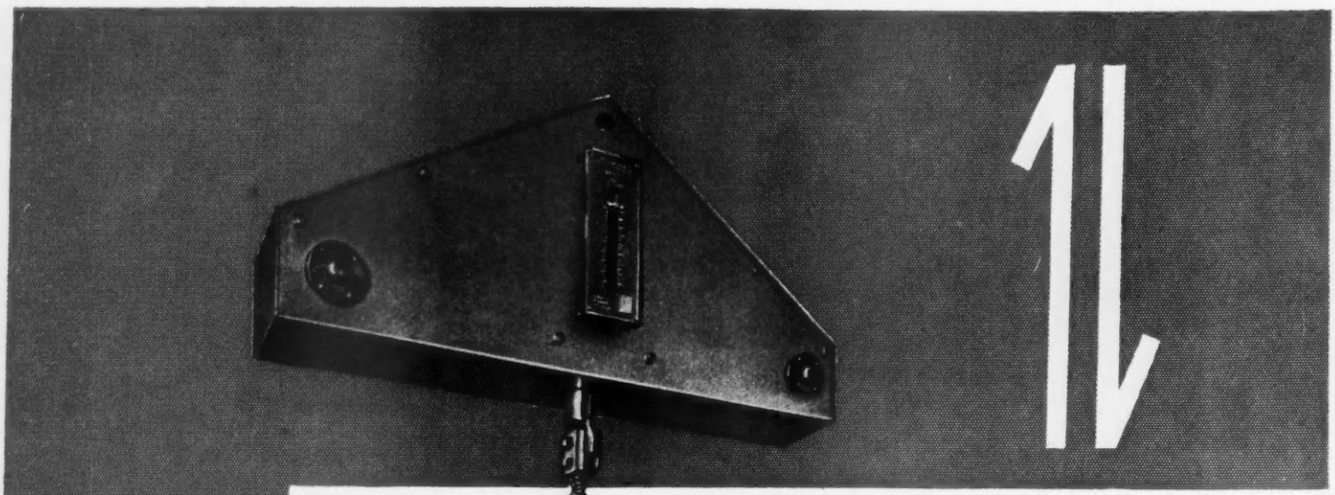
Hundreds of LINCOLN Automatic Welding Units are in use throughout the world.

May we advise on *your* problem?

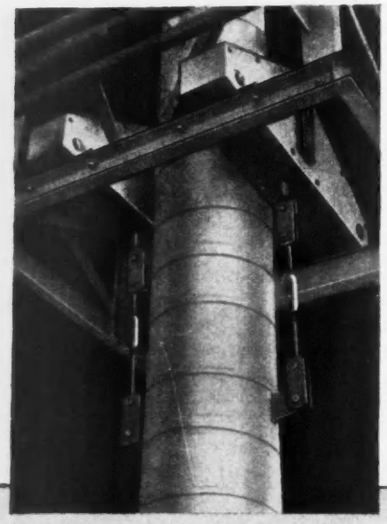
Write or telephone The Automatic Division.

LINCOLN ELECTRIC CO LTD

WELWYN GARDEN CITY
HERTFORDSHIRE
Welwyn Garden 920 (5 lines) 4581 (5 lines)



UNRESTRAINED THERMAL PIPE MOVEMENTS



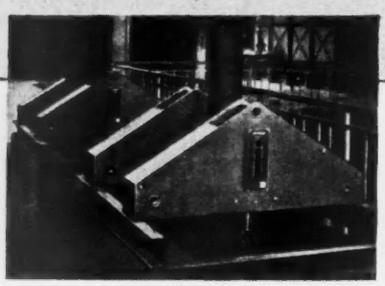
In modern power plants the main high temperature pipework systems are subjected to very large thermal movements and, if dangerous stress intensifications in the pipe walls and at terminal connections are to be avoided, it is essential that the support hangers balance the weight of the pipework and do not restrain its free expansion and contraction.

The Mark 1 UNILOAD constant load pipe support developed by Aiton & Co. Ltd. has proved an efficient and reliable unit. Many hundreds have been installed in power stations and industrial plants throughout the world.

Continuous research and development has enabled improvements to be effected in order to increase the range of application of this supporting unit. The Mark 2 UNILOAD, whilst embodying the tried and proved design features of the original unit, incorporates additional compensating equipment which ensures that the load deflection curve will not vary from the ideal straight line by more than plus or minus 2% of the rated load.

'UNILOAD' CONSTANT LOAD PIPE SUPPORTS

MARK 1 AND MARK 2



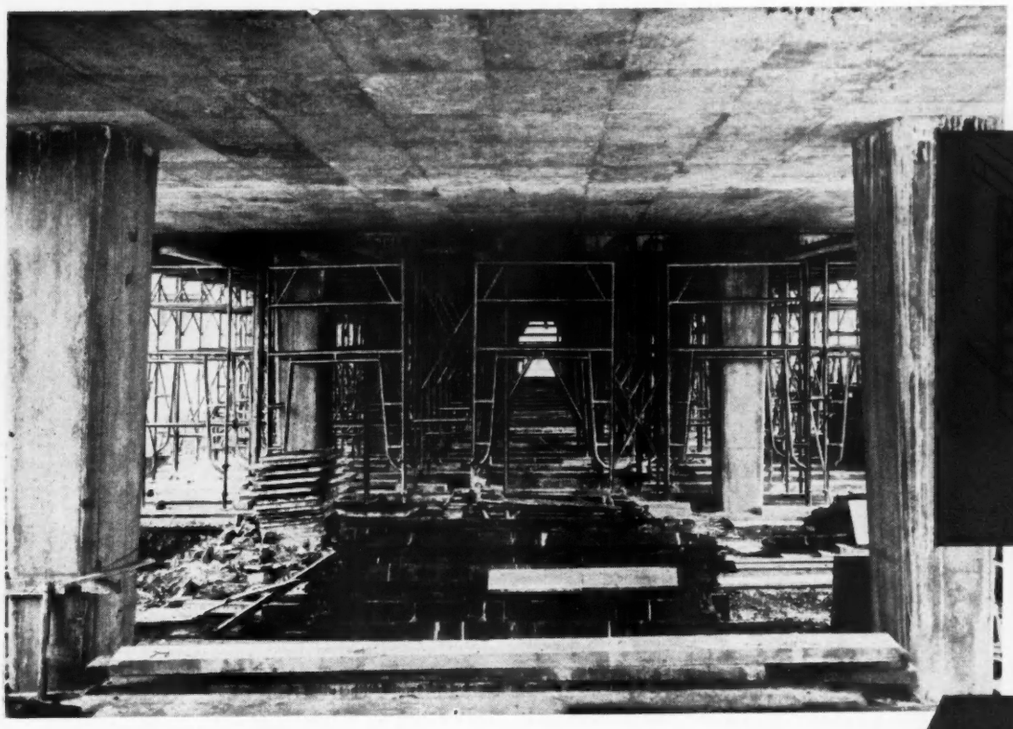
The Mark 2 UNILOAD is particularly suited to nuclear power plant or for any application where exceptional accuracy in load carrying characteristics are demanded.

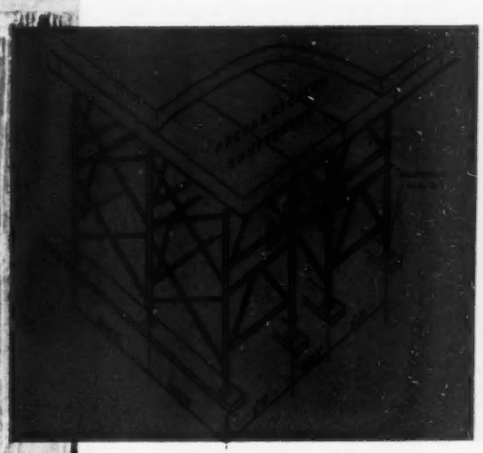
For over 50 years Aiton & Co. Ltd. have specialised in the design, manufacture and installation of **Pipework and Ancillary Equipment** *for the highest temperatures and pressures.*

AITON & CO. LTD. DERBY ESTABLISHED 1900

HEAD OFFICE · DERBY · · WORKS · DERBY & SUNDERLAND

TELEPHONE: DERBY 47111 (10 LINES) TELEGRAMS: CHANNELED DERBY





A concrete slab supported by joists, stringers or ledgers and Safway frames. Loads can be applied directly to frame legs and since their strength has been pre-determined, calculation of frame spacing is easily carried out.

CONCRETE SHORING WITH

Facts on shoring with Safway...

- Simplicity of handling speeds erection time, cuts labour costs.
- Stability and safety when erected give operatives greater confidence.
- Design of frames allow maximum floor clearance.
- Minute adjustment possible at base and top speeds joinery work.

investigate the cost-cutting potential of the system...

Sterling
SAFWAY UNIT FRAME
SCAFFOLDING

STERLING FOUNDRY SPECIALTIES LIMITED

LONDON Iddesleigh House, Caxton Street, S.W.1. Tel.: ABBey 3017 8 (2 lines)

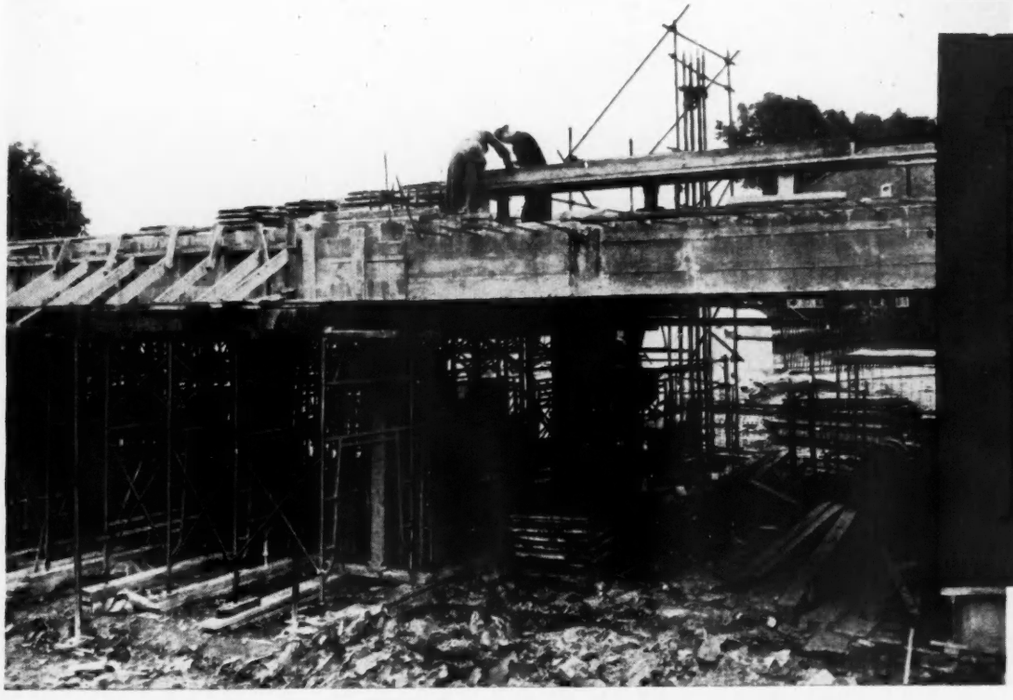
BEDFORD Sterling Works, Bedford. Tel.: Bedford 5338 (3 lines)

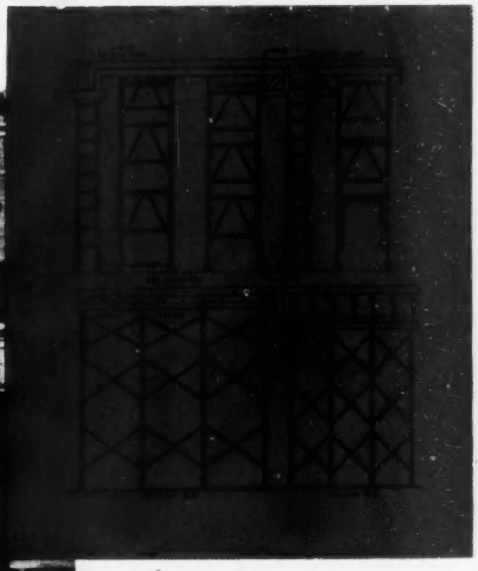
JARROW Sterling Factory, Jarrow, Co. Durham. Tel.: Jarrow 89-7721, 2/3

BRISTOL 175 White Ladies Road, Bristol, 8. Tel.: Bristol 39112

GLASGOW 28 Renfield Lane, Glasgow, C.2. Tel.: City 6201/2.

EDINBURGH 23 Rutland Square, Edinburgh, 1. Tel.: Fountainbridge 3254/5

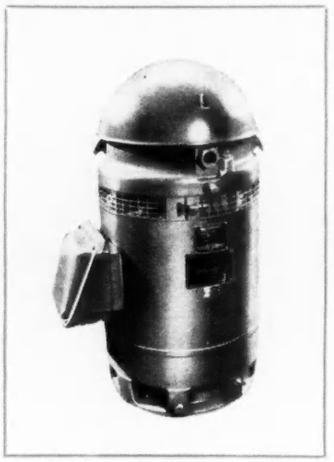




Typical forming conditions using Safway Frames and Ledgers. Adjustment can be provided at top and base of each frame.

ON THE SPOT SURVEYS

inspire Newman design when special conditions have to be met, as with the range of vertical solid and hollow shaft pump motors. A special survey was taken of the pumping industry and of the conditions under which such motors were required to operate before the designs were finalised. Now Newman Vertical Solid and Hollow Shaft Pump Motors lead the field in fitness-for-purpose and are securing contracts against world-wide competition.



YET ANOTHER EXAMPLE OF THE NEWMAN PROGRESSIVE DESIGN POLICY

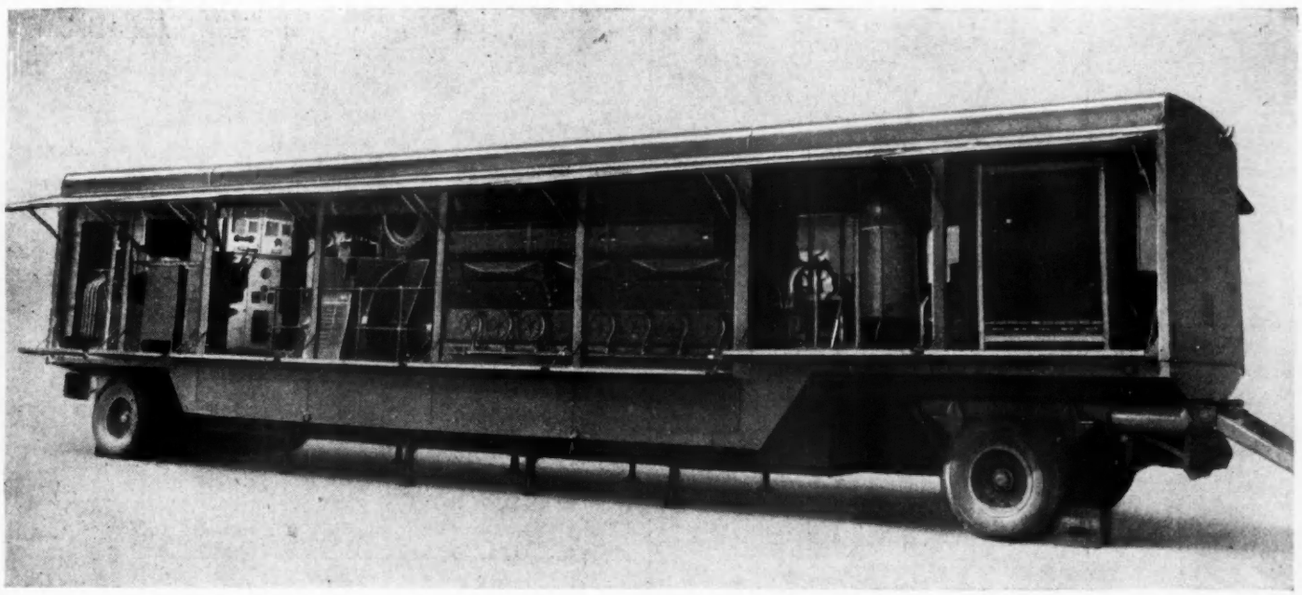
Newman

making the pace in motor progress

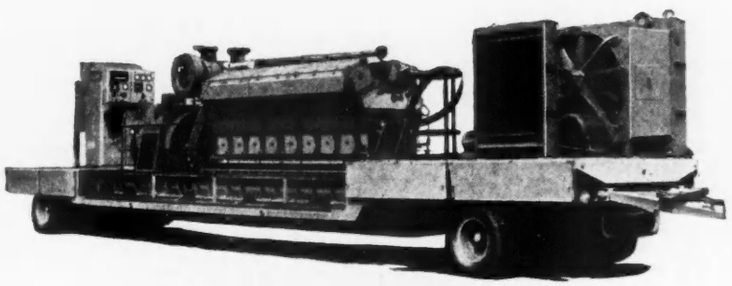
NEWMAN INDUSTRIES LIMITED, YATE, BRISTOL

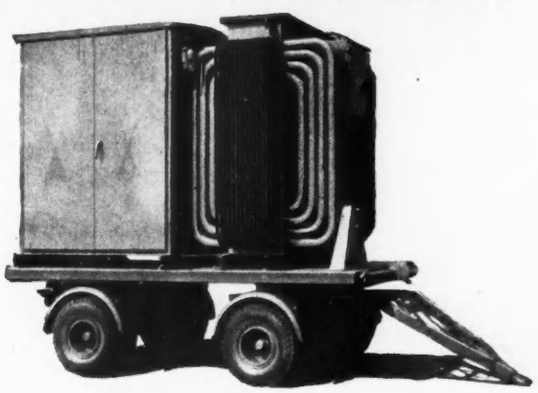
586

Cogent



Mobile Power for Venezuela





Four of the largest mobile generating sets ever constructed have recently been completed by Mirrlees, Bickerton & Day Ltd. for La Corporacion Venezolana de Fomento. Designed for use in townships and works where the local permanent power station is not sufficient to meet the demand, these diesel generators are capable of providing power for an average town.

The sets are made up of two trailers; one for generation the other for transformer duties. The power unit consists basically of a Mirrlees JVS.16 turbo-charged diesel engine with a continuous site rating at 900 r.p.m. of 1727 b.h.p. This drives a Brush 1200 kW generator, installed complete with switchgear and control panel.

The other trailer carries a Brush 1500 kVA Transformer which is capable of converting the full alternator output from 2,400 to 13,800 volts.

Mirrlees diesel power once again leads the way.

* **The photographs show:—**

TOP: *Complete Generation Trailer. Weight approx. 52 tons, 50 ft. long, 10 ft. wide, 12 ft. high.*

CENTRE: *Mirrlees JVS.16 diesel engine and Brush generator in process of being fitted on Generation Trailer.*

BOTTOM: *Transformer Trailer. Weight approx. 10 tons. 12 ft. 6 ins. long, 7 ft. 6 ins. wide, 12 ft. high.*

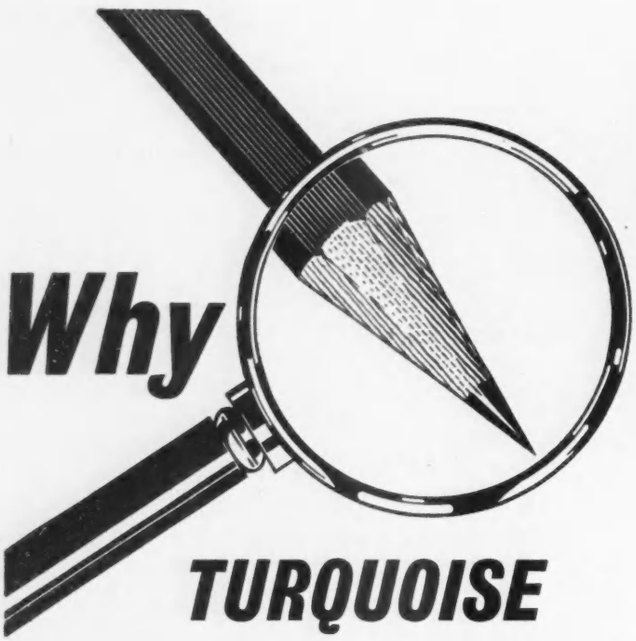
Mirrlees

diesels

MIRRLEES, BICKERTON AND DAY LIMITED · HAZEL GROVE · STOCKPORT · CHESHIRE

Telephone : Stepping Hill 3841 *A member of the Hawker Siddeley Group* *Telegrams :* "Mirrlees, Telex, Manchester"

IE24



Why TURQUOISE is not 'just another' drawing pencil

The lead in Turquoise pencils is something quite special. It is prepared from 100% electronic graphite, which after being cleansed of all impurities is spun to particles of 1/25,000 of an inch, then blended with clay and steeped in hot waxes.
A finer, more compact lead structure results, because millions more minute graphite particles are compressed into every inch of lead.

This lead structure makes Turquoise the most reliable pencil you can use. It ensures exceptional smoothness—this eases your work. It means less wear and greater resistance to point breakage—this saves time and money. It means denser, more opaque lines for cleaner, sharper reproductions.

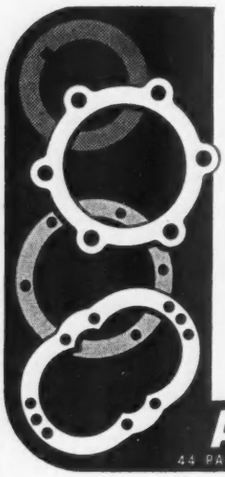
NOW ALSO AVAILABLE Turquoise drawing leads 2B to 6H

TURQUOISE GRADING IS TRIED AND TRUE
Turquoise pencils are made in 17 gradings. Each is compounded from a separate precisely controlled basic formula of graphite and clay, and each is therefore as uniformly spaced as the inches on your rule.

EAGLE
'CHEMI•SEALED' Super-bonded
TURQUOISE
DRAWING PENCILS
with 100% 'ELECTRONIC' Graphite

T14A

EAGLE PENCIL COMPANY · ASHLEY ROAD · TOTTENHAM, N17



FOR MILLING CUTTERS · SLITTING KNIVES AND SAWS · BALL AND ROLLER BEARINGS · GEARS AND MANY OTHER PURPOSES—

ARTUS

"THE COLOUR TELLS THE THICKNESS"

PRECISION PLASTIC SHIMS
From ·0005", ·001", ·0015" up to ·040"

EASY TO IDENTIFY · EASY TO USE
Write for Samples and Literature or Mail Blueprint for quotation

AUTO AERO LTD.
44 PACKINGTON ROAD LONDON W3 Telephone ACOrn 0544

The birth of New Techniques

Continually the frontiers of science advance, and our knowledge becomes more exact. At the same time the result is that new techniques are developed, used and discarded in favour of those yet newer. In steel structures it is now possible to take advantage of the economies possible when rigid designs are made. Welding has made many of these designs possible. Cleveland's important contribution has been in helping to make fabrication for such structures practicable and economic. Manipulators and handling equipment have been specially designed to reap full benefit of the automatic welding in which the Company specialises.

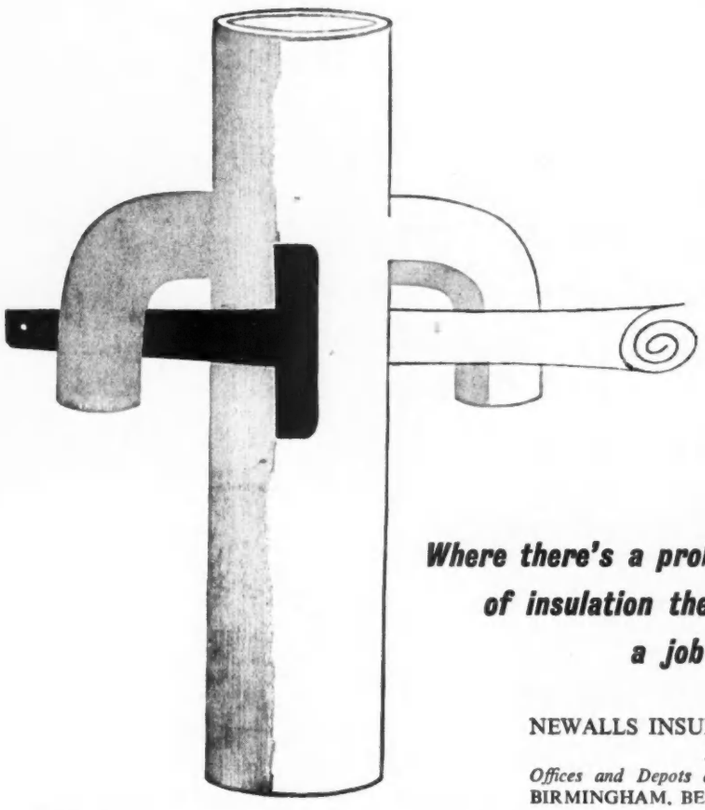
AN INVITATION
Our services are always available in design, in detailing, and in the costing and construction of all types of structures.

CLEVELAND
CONTRACTORS, BUILDERS OF BRIDGES AND CIVIL ENGINEERS

THE CLEVELAND BRIDGE & ENGINEERING CO. LTD. DARLINGTON.

2

INSULATION INVESTMENT
begins with Newalls



The post-war period has seen much industrial expansion. In terms of thermal insulation this has meant an increasing demand for more efficient insulation to cover all the temperature ranges of present-day industry. In fact we now provide insulation for temperatures as low as minus 300°F up to over 2000°F. The development of such products as Newalls 85% Magnesia and Newalls Newtempheit Insulation has proceeded hand in hand with improvements in insulation practice. Experience in many large industrial contracts, coupled with the work of our Research Laboratories, has found us equal to any new problem. In many power stations, oil refineries, industrial power plants, large cold stores and chemical plants, you will find evidence of the wide experience we as the country's largest thermal insulation manufacturers and contractors, have built up in a half century of operation. Based on this experience we offer free consultation on any aspect of insulation.

Where there's a problem of insulation there's a job for

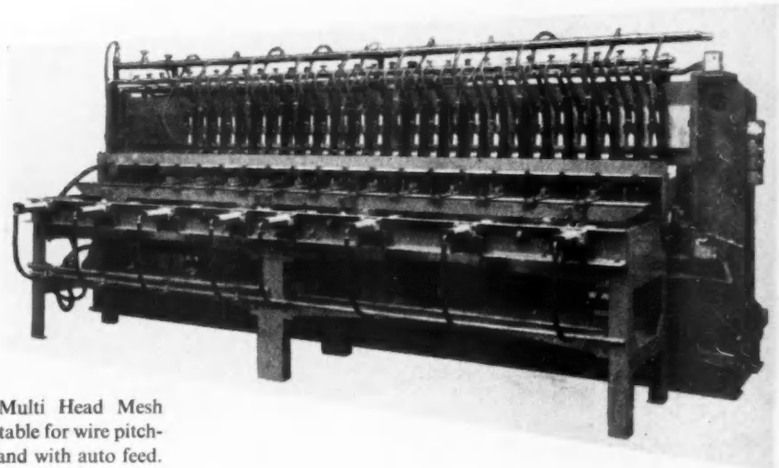
Newalls

NEWALLS INSULATION CO. LTD. *Head Office:* WASHINGTON, CO. DURHAM
A member of the TURNER & NEWALL ORGANISATION
Offices and Depots at LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE BIRMINGHAM, BELFAST, BRISTOL & CARDIFF. *Agents and Vendors in most markets abroad*

British Federal

Specialists in complete design and manufacture of all types of standard and special purpose resistance welding equipment from 1 KVA to 1500 KVA or greater, and including fully automatic conveyor and hopper fed lines for high production requirements in the automobile, aircraft, steel, drum and wire industries and all branches of engineering.

- Special Purpose Jigs and Fixtures.
- Press Tools and Dies.
- Electronic Controls.
- Tube Mills.
- Cycle Rim Forming and Welding Equipment.



British Federal 14ft. Multi Head Mesh Welding Machine adjustable for wire pitching from 1in. upwards and with auto feed.

LEADERS IN RESISTANCE WELDING

BRITISH FEDERAL WELDER & MACHINE CO. LTD.
1 CASTLE MILL WORKS, DUDLEY, WORCS.
TELEPHONE DUDLEY 3114

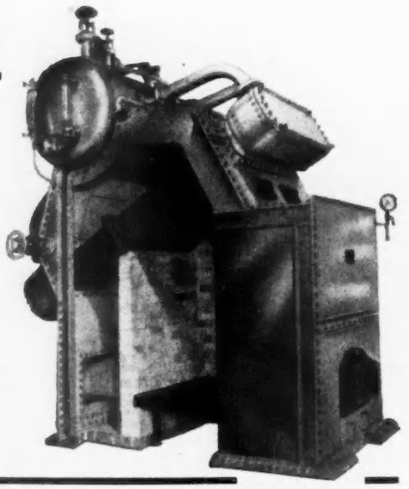
When Replacing Obsolete STEAM BOILERS

INSTAL THE
FRASER
WATER-TUBE
BOILER

Unsurpassed for efficiency and versatility, the Fraser Boiler has the distinctive merit that it incorporates a large brick-lined smoke consuming combustion chamber, thus complying with the requirements of the Clean Air Act.

Write for illustrated literature

FRASER & FRASER LTD.
Bromley-by-Bow, London, E.3.
Telephone : ADVance 3266 (4 lines)
Telegrams : Pressure, Easphone, London.



MAINTAIN GREATER OUTPUT...
HIGHER EFFICIENCY...
WITH MAXIMUM ECONOMY...

from LOW VOLATILE and
OTHER SMOKELESS FUELS by
installing

TURBINE FURNACES

REMEMBER POPPY DAY

which give higher plant efficiency
All enquiries to :
THE TURBINE FURNACE CO. LTD.
238b, Gray's Inn Road, London, W.C.I. Tel: TERminus 4365

MAGNOLIA
ANTIFRICTION METALS

- For heavy loads and high speeds in engine and industrial plant bearings

FLOWER BRAND
NAVY BRONZE
TURBEX
T.C. ALLOY
OIL ENGINE
CRUSHER BRAND

MAGNOLIA ANTIFRICTION METAL CO.
OF GREAT BRITAIN LTD
34, VICTORIA STREET, LONDON, S.W.1

● We supply each BRONX Plate Bending Rolls with a capacity chart (as illustrated) from which you can readily determine the complete range of widths and thicknesses and minimum diameters the machine will roll.

This information is of the greatest possible value to your Estimating Dept. in the first place—and secondly to the roller operator working the machine.

There is a wide range of massively built Bronx Plate Bending Rolls to give consistent accuracy with thinnest to thickest steel plates up to 25ft. in width, and standard machines cope perfectly with conical work.

For accurate estimating and exact operation . . .

Illustrated is a BRONX 3-roll Initial Pinch 6′ x $\frac{3}{8}$″ capacity machine. There are also BRONX Press Brakes, Guillotine Shears, Sheet and Plate Levelling Machines, etc. Catalogues on request.

BRONX
PLATE BENDING ROLLS

Telephone: LYE 2307 & 2308
BRONX ENGINEERING CO. LTD., LYE, WORCS.

Where

CONTROL

is important

Macfarlane Rotary Amplifiers provide a means of precise control of electric and non-electric quantities—speed, voltage, power, load, etc. Machines are available with outputs of from 1 to 5 KVA, and each is designed for the special application required. Amplification is possible up to 100,000, or even more with a pre-amplifier. Macfarlane Rotary Amplifiers can be supplied for belt drive from existing equipment or as a separate motor generator set.

Macfarlane **ROTARY AMPLIFIERS**

THE MACFARLANE ENGINEERING CO. LTD.

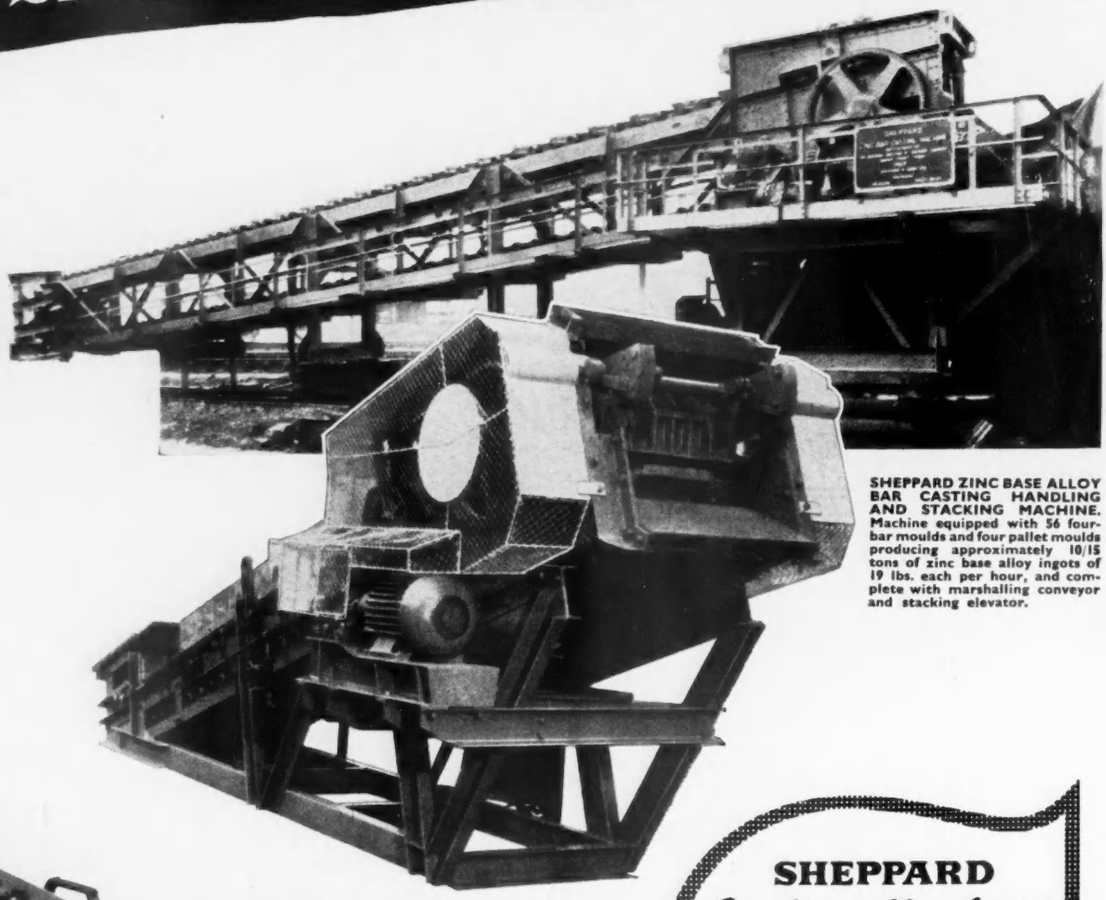
Netherlee Road, Cathcart, Glasgow, S.4

Telephone: Merrylee 2255-7

INGOT CASTING *the modern way!*

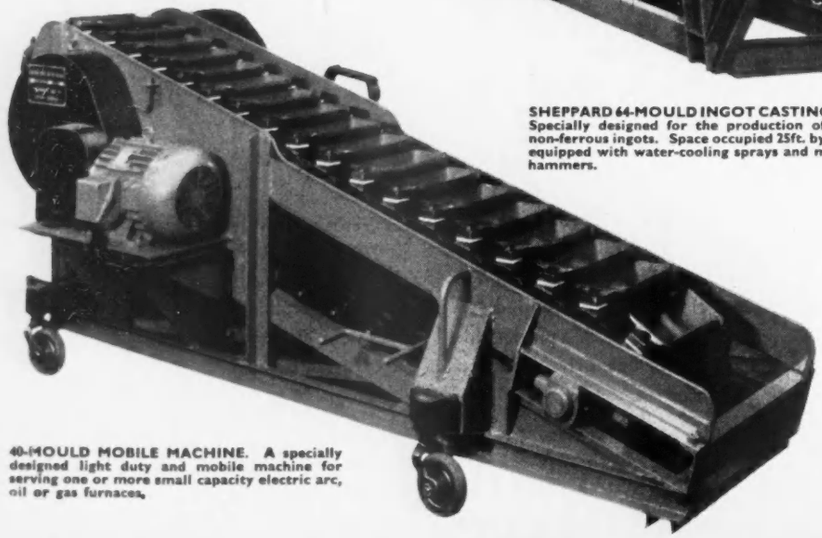
with SHEPPARD *Casting Machines*

More and more Ingot Producers are realising that mechanisation is fast replacing hand casting . . . and mechanical casting means SHEPPARD'S — designers and manufacturers of a complete range of Casting Machines which incorporate all the features of traditional methods, but which are compact, self-contained and economical in labour, space and time.



SHEPPARD ZINC BASE ALLOY BAR CASTING HANDLING AND STACKING MACHINE. Machine equipped with 56 four-bar moulds and four pallet moulds producing approximately 10/15 tons of zinc base alloy ingots of 19 lbs. each per hour, and complete with marshalling conveyor and stacking elevator.

SHEPPARD 64-MOULD INGOT CASTING MACHINE. Specially designed for the production of ferrous and non-ferrous ingots. Space occupied 25ft. by 7ft. Machine equipped with water-cooling sprays and mould rapping hammers.



40-MOULD MOBILE MACHINE. A specially designed light duty and mobile machine for serving one or more small capacity electric arc, oil or gas furnaces.

SHEPPARD *Casting Machines* CAN PRODUCE **INGOTS** *in* ALUMINIUM · BRASS · BRONZE & GUNMETAL · COPPER · LEAD · ZINC REFINED & PIG IRONS etc.

Write for full particulars.

SHEPPARD

SHEPPARD & SONS LTD · BRIDGEND · GLAM

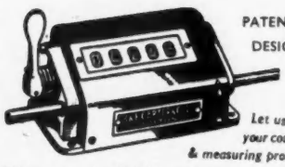
Tel: BRIDGEND 567 (5 lines) 'Grams: SHEPPARD BRIDGEND

LONDON OFFICE: 153 GEORGE ST., W.1. Tel: PADDINGTON 4239

REPRESENTATIVES IN SOUTH WALES FOR— **G.W.B. ELECTRIC MELTING & RESISTANCE FURNACES and ELECTRIC CONTROL GEAR**

ALBION

Ratchet and Revolution Counters



PATENTED DESIGN

Let us solve your counting & measuring problems

There is an 'ALBION' ratchet or revolution counter for every application. Fit your machines with these efficient counting instruments which will show your output at a glance.

INSTRUMENT DIVISION

B. & F. CARTER & CO. LTD.

BOLTON 3, ENGLAND

'Phone: BOLTON 4344 (3 lines)
'Grams: BRAIDERS BOLTON

Specify MICHELL AND MAKE SURE OF YOUR BEARINGS

THEY SET THE COURSE FOR RELIABILITY

FOR Turbine Thrusts, Pedestal Bearings, Hydro-Electric Installations, Motors, Generators, Paper Making and Extruding Machines, Pumps, Fans, Etc., Etc.

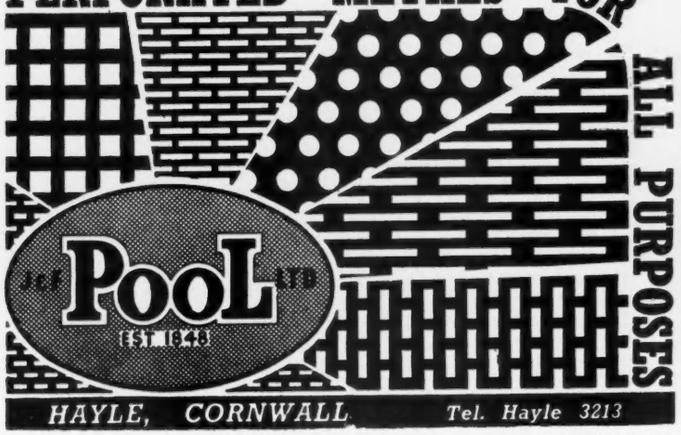
MICHELL BEARINGS LTD

SOUTH BENWELL

NEWCASTLE upon TYNE, 5

Telegrams: MICHBEARO Telephone: 3427

PERFORATED METALS FOR ALL PURPOSES



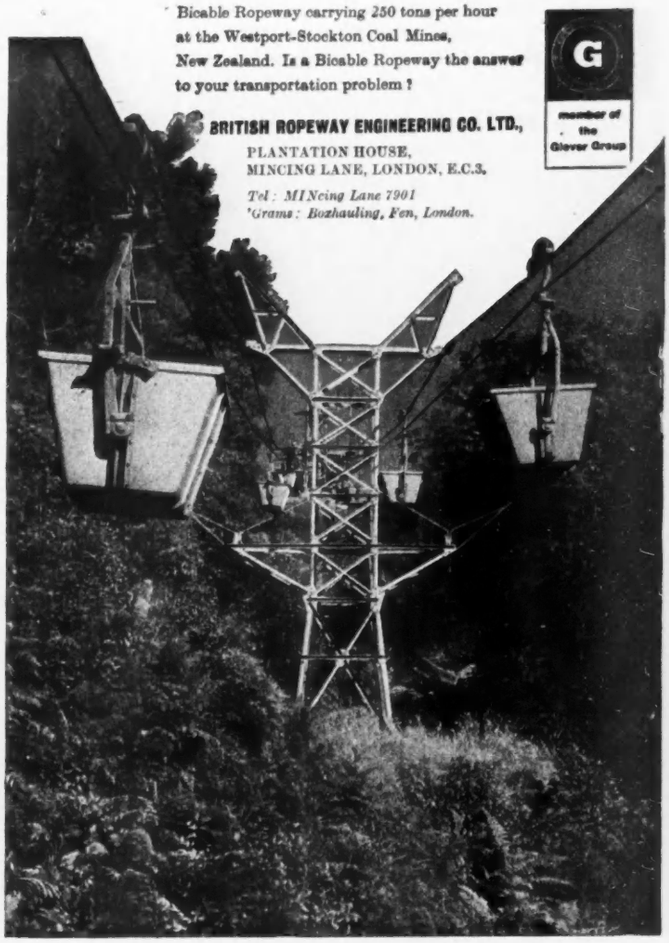
HAYLE, CORNWALL Tel. Hayle 3213

Bicable Ropeway carrying 250 tons per hour at the Westport-Stockton Coal Mines, New Zealand. Is a Bicable Ropeway the answer to your transportation problem?

BRITISH ROPEWAY ENGINEERING CO. LTD.,
PLANTATION HOUSE,
MINCING LANE, LONDON, E.C.3.

Tel: MINcing Lane 7901
'Grams: Boxhauling, Fen, London.

G member of the Glover Group



For magnified output . . . use mechanical tubing . . .

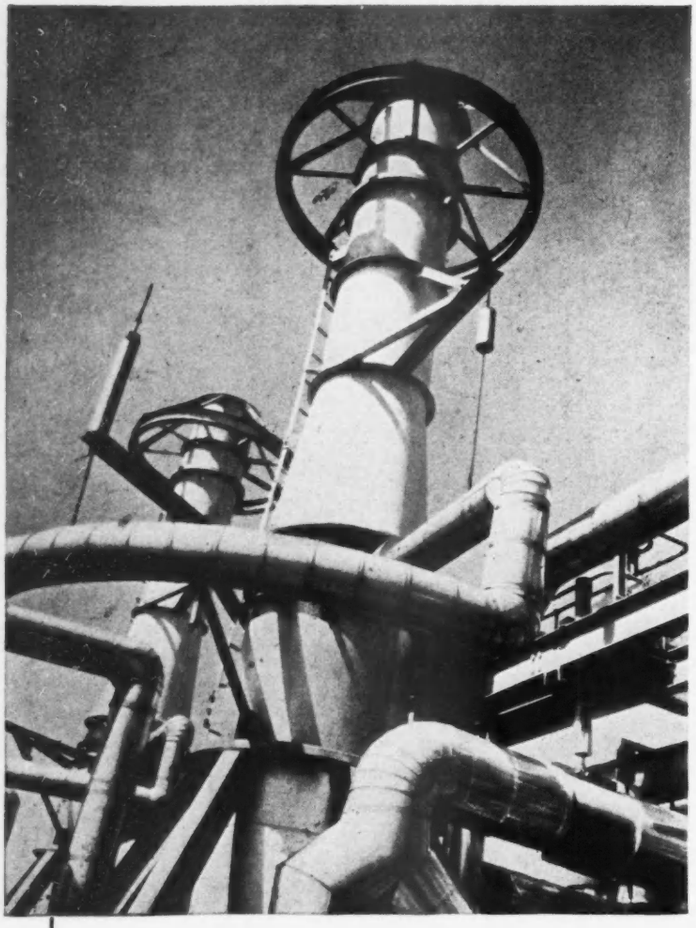
Mechanical tubing can be used for rollers, piping at high pressures or for ring shaped machine tool parts, and in numerous other ways. Its use can make substantial savings to your labour, time and material costs.
We carry considerable stocks of tubing in various sizes, finishes, diameters and lengths, so should you require yards and yards of tubing in different sizes, etc., we will probably be able to supply all your needs *immediately* and in *one delivery*.

Write, phone or call for full particulars

Markland Scowcroft LIMITED

BROMLEY CROSS, Nr. BOLTON Phone: EAGLEY 600 (5 lines)

R.H.J/M131



GENSPRINGS
at Forth Chemicals

At the Grangemouth Works of Forth Chemicals, Vokes Genspring Variable Support Hangers provide safe, secure support for the long runs of piping.
These Variable Supports are complementary to the Vokes Genspring range of Constant Supports and are designed for use on pipelines where conditions are less critical, but where proper provision must be made for the effects of thermal expansion. Variable Gensprings are available in 16 sizes and include three travel ranges—1¼", 3" and 6". Each of these three travel ranges covers the same load, i.e. 58-6895 lbs. Whatever the piping Vokes Genspring Variable Supports offer dependable control of vibration and limited thermal movement. Full details are available in our Catalogue which will be gladly sent on request.

with Vokes Genspring Variable Support Hangers:

* No springs to design
* Merely quote Catalogue number
* Delivered ready for erection
* Takes its correct design load

VOKES GENSPRING SUSPENSION SYSTEMS
DEPT. H 5 VOKES GENSPRING LTD · GUILDFORD · SURREY

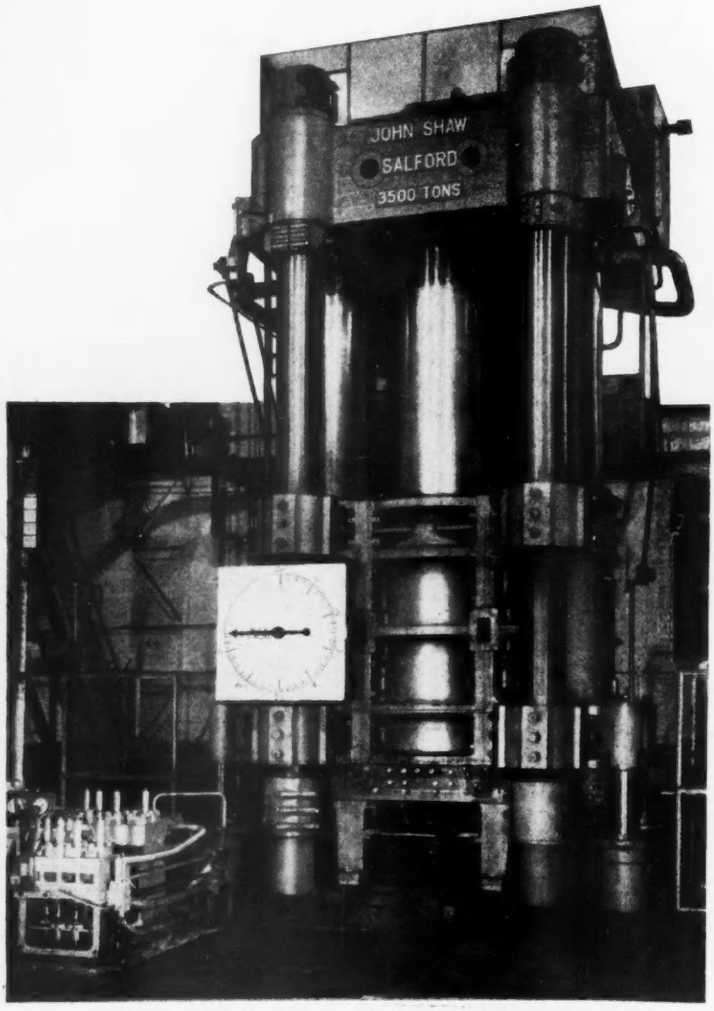
VH/26

JOHN SHAW
Makers of fine presses

Hydraulic presses for all manner of industry, with a reputation that is second to none, come from JOHN SHAW. A reputation that is built on advanced design, craftsmanship in manufacture and a care for individual detail that ' tailors ' each press to its user's requirements.

Such a press is the 3500 ton heavy duty forging press of the moving cylinder type shown, on site, below. Double guiding is incorporated to ensure accuracy of forging in a press which, incidentally, has a dead weight of 350 tons.

For whatever purpose you need a hydraulic press you will do well to consult JOHN SHAW.



JOHN SHAW & SONS (SALFORD) LTD
SALFORD LANCASHIRE

JS12

AFTER 125 YEARS

ALL METALWORKING TRADES still demand COATED ABRASIVES by

OAKEY

IN ROLLS · BELTS · DISCS & SHEETS

ESTABLISHED 1833

John Oakey & Sons Ltd · Wellington Mills · London SE1

OA86C

MATERIAL HANDLING EQUIPMENT Standard or to your own specification

BENCHES
SPECIAL PURPOSE BOGIES
FLAT PALLETS
SWARF REMOVAL TRUCKS
TUBE OR BAR STORAGE RACKS
FOUR-WAY ENTRY ALL STEEL PALLETS
GRAVITY ROLLER CONVEYORS
TEXTILE BOGIES
MOBILE STILLAGES
THE "TUDOR" TOOL CABINETS
INDUSTRIAL TRAILERS
HAND OR TRAILER DRAWN INDUSTRIAL TRAILERS
HEAVY DUTY STACKABLE PALLETS
BRICK & TILECURING PALLETS

All Steel Factory Equipment saves Time, Space, Money.

★ ALSO GENERAL FABRICATION WORK.
ENQUIRIES INVITED

JOHN S. YOUNG & CO., LTD.

MARYVILLE AVENUE, GIFFNOCK, GLASGOW.

Telephone: Giffnock 1101 (6 lines) Telegrams: 'Stedmacs Giffnock Glasgow.'

The Steel-Shaw Patent Flexible Coupling

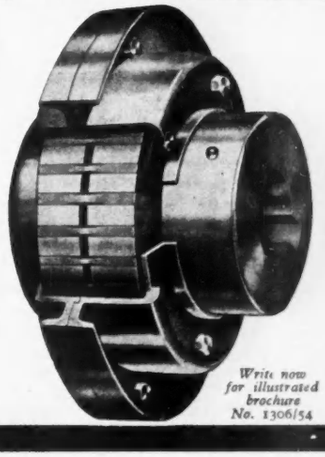
THE SECRET IS IN THE DESIGN It is the shape of the springs—separate individual keys which give the high degree of efficiency.

Greater safety as stresses are equally divided. Perfect balance at all speeds. Rarely requires lubrication, as a lubricant is packed inside couplings.

Smaller total diameter to transmit a given torque than other couplings of similar type.

Machined all over. Capacity from ·0125 to 24·80 B.H.P./R.P.M.

Diameter from 4½ to 38 ins.



Write now for illustrated brochure No. 1306/54

There's a STEEL-SHAW answer to YOUR problem

Steele & Cowlishaw Ltd., Dept. 16, Cooper Street, Hanley, Stoke-on-Trent
Telephone: Stoke-on-Trent 23333 (5 lines). Telex 36-530.
London Office and Overseas Sales: Baker Perkins (Exports) Ltd., Westwood House, Swallow Street, Piccadilly, London, W.1.
Tel: REGent 8301

A Member of the Baker Perkins Group.

10532/SCL

Makers of Fine Quality Precision Springs for over a Century-
BROADBENT'S UNCONDITIONAL Guarantee UNDER NORMAL USAGE QUALITY SPRINGS

BROADBENT & CO. (ROCHDALE) LTD.
Grove Spring Works, LINCOLN STREET,
ROCHDALE, Lancs. Phone:-Rochdale 4628-9

absterge
(to clean by wiping)

Austins supply the best cleaning rags for every type of purpose. Some jobs call for coarse, heavy fabric, some for soft, closely woven materials—we can meet all requirements with carefully selected rags that are thoroughly washed and sterilised in our own plant. Orders of all sizes are handled with promptness and reliability. Please let us quote you for regular supplies.

E. AUSTIN & SONS (LONDON) LTD.
GUN WHARF, GUNMAKERS LANE, E.3. Tel: ADVance 1211

Samuel Marsden & SON LTD.
Altrincham St., Manchester 1
London: W. Kelway-Bamber & Co. Ltd., Room 7, 70 Victoria Street, S.W.1. Tel: Abbey 6860
N.E. Coast: Fasteners Ltd., 2 Hall St., Barnard Castle, Co. Durham. Tel: Barnard Castle 3172
dmSM44

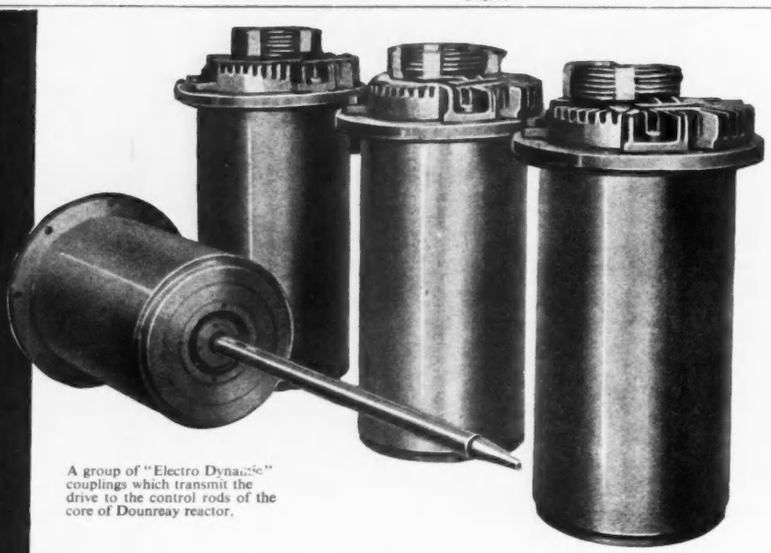
FARRAR BOILERS
FOR ALL INDUSTRIAL PURPOSES
including installations for
GASWORKS · HOTELS
HOSPITALS · SCHOOLS
PITHEAD BATHS
PUBLIC BUILDINGS
GRAIN SILOS Etc.
THE FARRAR BOILERWORKS
NEWARK (NOTTS) ENGLAND
Telegrams: Farrar, Newark 1143
Telephones: Newark 1143-4-5
RAISE STEAM WITH A "FARRAR"

At Dounreay...

The twelve groups of fuel rods used in the Reactor Core each have an "Electro Dynamic" magnetic coupling incorporated in the regulating mechanism which allows the drive to be transmitted through the reactor vessel without leakage of fission products. The 10 safety rods containing boron are similarly equipped.

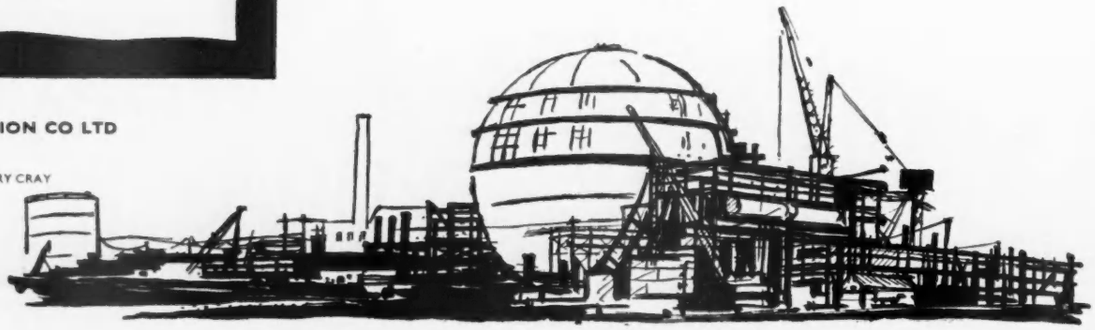
The Electro Dynamic Coupling is being specified in increasing numbers for drives where a positive seal against the leakage of gases or liquids is important. The drive is transmitted to the driven member by magnetic lines passing through a hermetically sealed shroud which separates the two members. There are no slip rings or revolving parts other than the driving and driven members. The whole construction is of a simple and robust nature requiring no maintenance other than occasional lubrication of the ball bearings.

For nearly half a century E.D.C.C. have dealt with special requirements for electrical equipment and the Company's design engineers are always willing to discuss customers' specific problems on Electrical Revolving machinery and Control gear.



A group of "Electro Dynamic" couplings which transmit the drive to the control rods of the core of Dounreay reactor.

ELECTRO DYNAMIC CONSTRUCTION CO LTD



ELECTRO DYNAMIC CONSTRUCTION CO LTD
ST MARY CRAY KENT
Tel: ORPINGTON 27551 Grams: ELEDAMIC ST MARY CRAY
Control Gear Division:
Bridgwater Somerset Tel: Bridgwater 2882
Glasgow Office:
40 Houldsworth Street C3 Tel: Central 2620

P877

MILLS grooved pins

NO REAMING

NO TAPPING

DRILL AND DRIVE HOME!

12 different types to suit all needs

EXORS. OF JAMES MILLS LTD.

BREDBURY STEEL WORKS
WOODLEY. NR. STOCKPORT
Telephone: WOODLEY 2231.(10 lines) Telegrams: "MILLS" PHONE WOODLEY

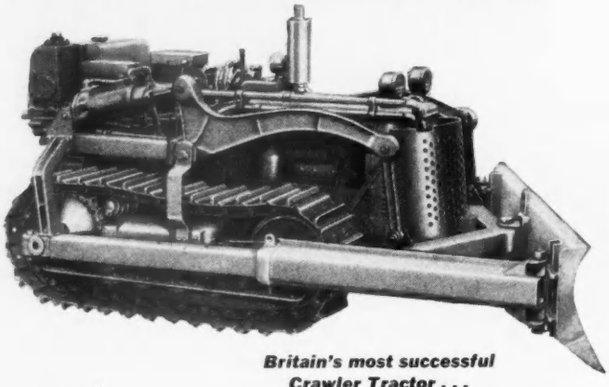
Remember... IT'S INTERNATIONAL CONSTRUCTION EQUIPMENT

For the Biggest Show on Earth!

Available Now!
The new British-made

Big BTD-20
with full reversible transmission

- Powered by 124 b.h.p. Rolls-Royce engine.
- Hydraulic power-steering.
- Greater productive capacity and flexibility.



Britain's most successful Crawler Tractor . . .

The International BTD-6 with the International Bullgrader

- Most powerful, most versatile tractor in its size class—also powers the world-famous International Drott B-6K-3 Skid-Shovel.
- Full range of British-built matched equipment.

Public Works Exhibition

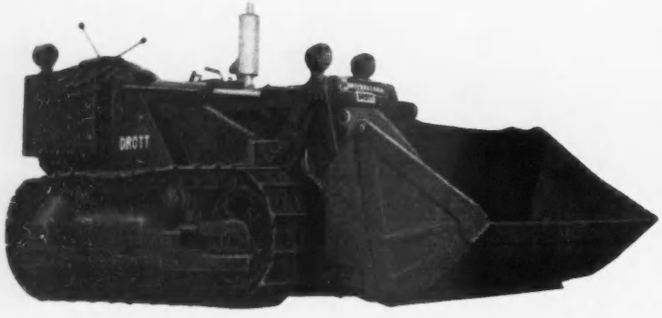
Also see the 9K-3 International Drott Skid-Shovel and the TD-24 (241 series) Diesel Crawler Tractor

ON STANDS 211 and 223

Now . . . International Drott B-6K-3 Skid-Shovel

Has even bigger breakout!

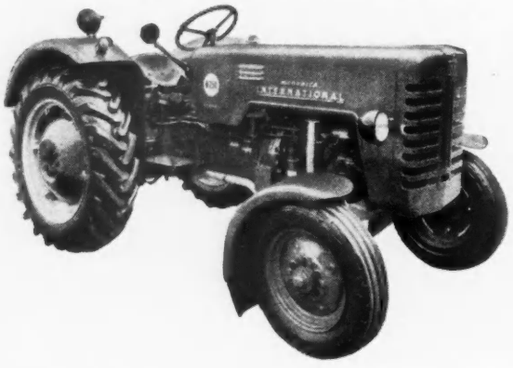
- 12,200 pounds with 1 cu. yd. bucket . . . equal to four times lifting force!
- 15,600 pounds with 4-in-1 bucket . . . equal to five times lifting force!
- The full Drott range has bucket capacities of 1 to 3 cu. yds.



International B-250 all-work Wheel Tractor

Gives versatile diesel power for big range of equipment

- Power for 'dozing, scooping, loading, winching, etc.
- Differential lock beats wheel spin on slippery sites.
- Truly 'live' hydraulics, uninterrupted by clutch and independent of power take-off.



Whether you can get to the Public Works Exhibition or whether you cannot, remember that you are all set for the *biggest show on earth* when you ask your local International Construction Equipment Dealer to demonstrate any of the superb machines in the International Construction Equipment range. Whatever the operation—bullgrading, loading, scraping, scooping—there's an International machine with matched equipment that's 'right' for the job . . . right for size, right for power, and right for work output.

INTERNATIONAL HARVESTER

International
CONSTRUCTION EQUIPMENT

International

CONSTRUCTION EQUIPMENT DEALERS IN GT BRITAIN AND N IRELAND

JAMES BOWEN & SONS LTD
EDINBURGH, GLASGOW & ABERDEEN

R. CRIPPS & CO LTD
NOTTINGHAM, MANCHESTER & SHILDON

SAVILLE TRACTORS LTD
LONDON, STRATFORD-ON-AVON, CARDIFF & BELFAST

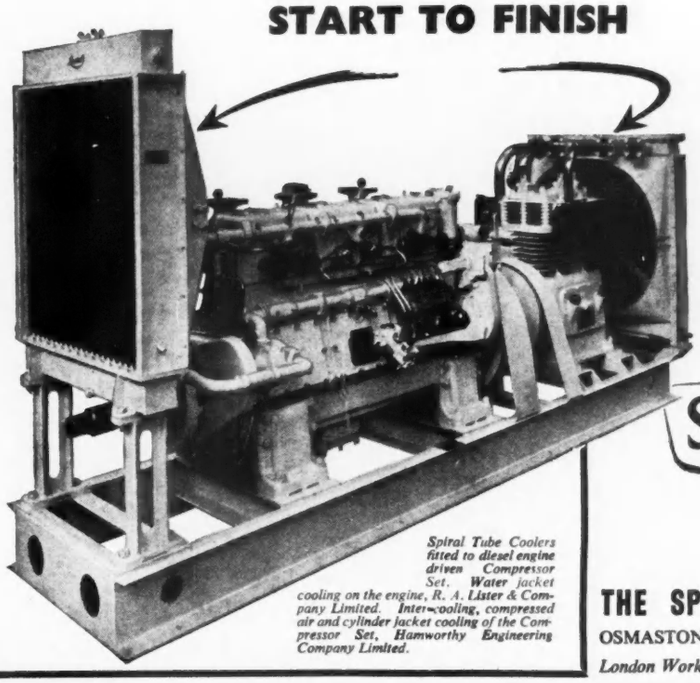
WESTERN CONTRACTORS SERVICES
BRISTOL

INTERNATIONAL HARVESTER COMPANY OF GREAT BRITAIN LIMITED · HARVESTER HOUSE · 259 CITY ROAD · LONDON EC1

COOLING

FROM

START TO FINISH



Spiral Tube Coolers fitted to diesel engine driven Compressor Set. Water jacket cooling on the engine, R. A. Lister & Company Limited. Inter-cooling, compressed air and cylinder jacket cooling of the Compressor Set, Hamworthy Engineering Company Limited.

PLEASE HELP PLASTICS

Backed by fifty years of technical experience and "know-how", Spiral Tube Engine Coolers are soundly engineered and robustly constructed for long, trouble-free service, and are renowned for their high efficiency and great resistance to vibration. They have a wide range of applications and are in world-wide service on all the principal railways throughout the world. Coolers are also manufactured for use in connection with generators, alternators, etc.

★ *Consult our Technical Advisory Service*

SPIRAL TUBE
Engine Coolers

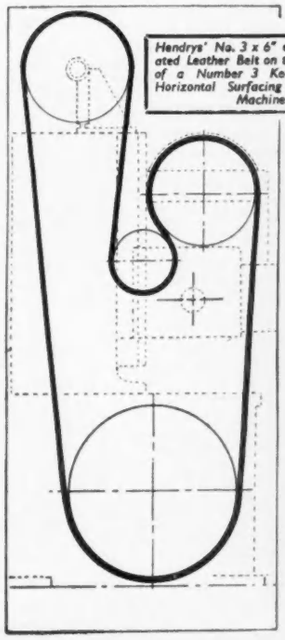
THE SPIRAL TUBE & COMPONENTS CO. LTD

OSMASTON PARK ROAD, DERBY TEL: DERBY 48761 (3 lines)

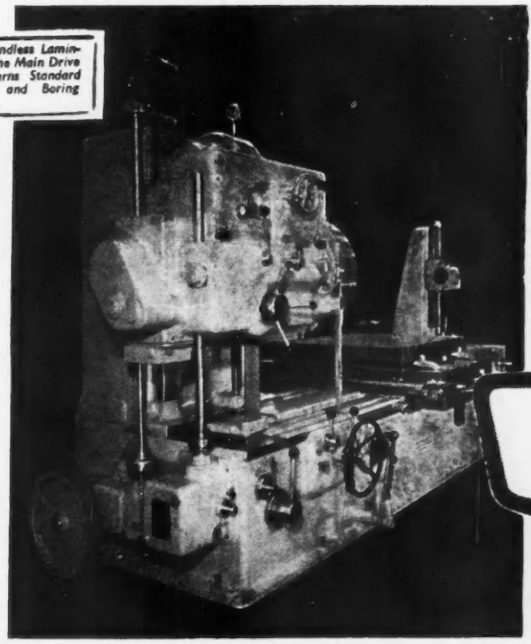
London Works: Honeypot Lane, Stanmore, Middlesex. Tel: Edgware 4568/9

It must be a Hendrys' Belt–

HENDRYS' Belts are flexible in both directions. Made of Solid Leather, any length endless, and up to one inch thickness in a single ply. Adjustable. Absence of fasteners and strict uniformity of weight give a smooth vibrationless drive and flow without ripple or whip. Edge of hide contact ensures adhesion without tension, thus minimizing wear of belt and bearings. Economical too.



Hendrys' No. 3 x 6" endless Laminated Leather Belt on the Main Drive of a Number 3 Kearns Standard Horizontal Surfacing and Boring Machine.



SIZES AND WEIGHTS

Hendrys' Patent Laminated Leather Belts are made in eight standard weights to following widths :—

No. 0.	¼	in.	thick up to	3	in. wide
No. 1.	5/16	in.	,, ,,	7	in. ,,
No. 2.	⅜	in.	,, ,,	12	in. ,,
No. 3.	½	in.	,, ,,	any	width
No. 4.	⅝	in.	,, ,,	,,	,,
No. 5.	¾	in.	,, ,,	,,	,,
No. 6.	⅞	in.	,, ,,	,,	,,
No. 7.	1	in.	,, ,,	,,	,,

The No. 0 is a specially pliable belt made to order for light driving at high speeds and Nos. 5 to 7 are for Main or Heavy Driving.

Hendrys' make Laminated Friction Belts for Screw Presses, also.

Hendry's BELTS

JAMES HENDRY LTD.

252 Main Street, Glasgow, S.E

London · Birmingham · Manchester · Johannesburg

500 TONS PER HOUR FROM CLAYPIT TO BRICKWORKS • •

• • carried on Sutcliffe conveyors

Photographs reproduced by permission of THE LONDON BRICK CO. LTD.

1 RECEIVING HOPPER

2 PLATE FEEDER

3 PICKING BELT FOR REMOVAL OF STONES

4 KIBBLER TO BREAK CLAY TO 9" LUMPS

5 FEEDER BELT TO MAIN CONVEYOR

ALL MOBILE TO FOLLOW THE WORKING FACE

6 36" WIDE BELT SYSTEM TO THE BRICKWORKS

RICHARD SUTCLIFFE LIMITED

HORBURY • WAKEFIELD • ENGLAND

HOT? COLD? CORROSIVE?

Pass your problems to **F.T.M.**

Ask us about machines that resist Hot, Cold or Corrosive conditions (made in stainless steel and other metals) and you will find our design and technical staffs very keen to help you. We have the experience — probably we have met *your* problem. Anyway, do please ask.

A Stainless Steel Vacuum Box incorporating a series of Glass Portholes to give maximum visibility during a process of de-aerating.

FREEMAN, TAYLOR MACHINES LTD.

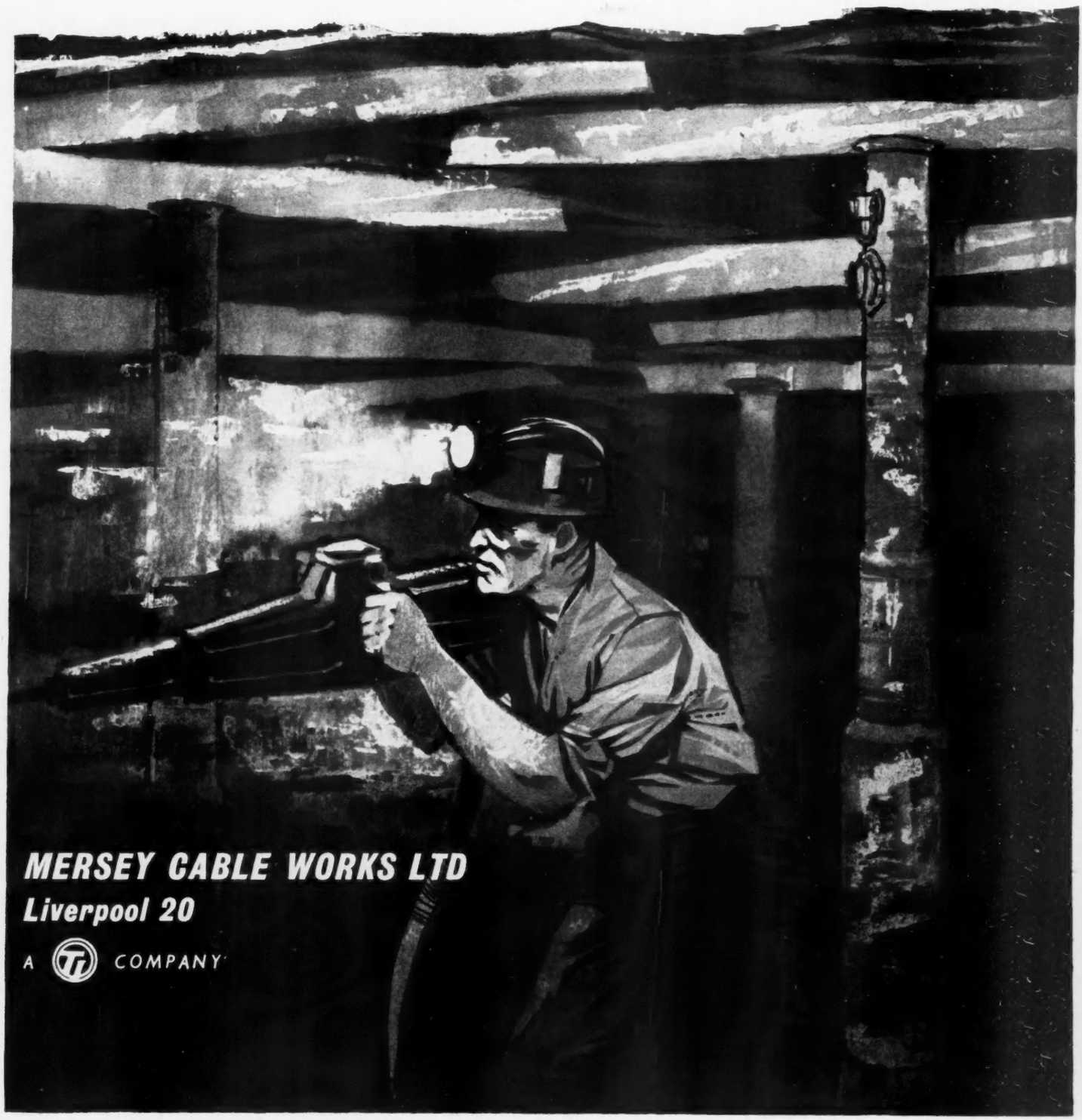
MERSEY CABLES
are tough and flexible

For piping power to modern coal-cutting and quarrying equipment the need is for cables that are tough enough to withstand the extreme conditions at the face without sacrificing flexibility.

Mersey produce such cables. By the application of modern techniques, first rate plant and materials—Mersey provide the answer.

In addition, Mersey manufacture cable for other services including roadway lighting, telephones and controls. Should you at any time need the help of cable technologists on any matter related to mining requirements, Mersey will willingly put the technical resources at your disposal.

Additionally, you will find a Mersey depot close at hand, ready to supply your stock cable needs promptly and to offer an on-the-spot advisory service.



MERSEY CABLE WORKS LTD
Liverpool 20
A COMPANY

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.

There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch.

There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CITY OF LIVERPOOL EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

Principal : S. A. J. PARSONS, B.Sc. (Econ.), M.I.Mech.E., M.I.Prod.E., M.B.I.M.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

PRODUCTION ENGINEERING SECTION

LECTURER

The Governing Body invite applications for the appointment of LECTURER IN PRODUCTION ENGINEERING. Salary : Lecturer, Men, £1200 by £30 to £1350 per annum (1956 Burnham Technical Report). Commencing salary on this scale may be assessed according to previous industrial or professional experience. Applicants must have had appropriate industrial experience and teaching experience is desirable. They should be able to teach up to the Higher National Certificate and Diploma level. The person appointed would be encouraged to undertake research, and to make contact with industry. He should be capable of leading the Section and assisting in its progress and development under the Head of Department.

This is a Regional College providing courses at the advanced level. It possesses adequate facilities in this specialist field. The intention is to develop Production Engineering studies, particularly in the provision of post-advanced courses and in applied research.

Further particulars and application form (returnable by 21st November, 1958), may be obtained from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority.

(J.5376.) E9031

UNIVERSITY OF NEW SOUTH WALES, SYDNEY, AUSTRALIA

VACANCY FOR
SENIOR LECTURER
IN MECHANICAL ENGINEERING

The University invites applications for appointment to the position of SENIOR LECTURER IN MECHANICAL ENGINEERING to specialise in Thermodynamics. Duties of the position include the development of post-graduate courses in the fields of gas turbines, heat transfer and combustion. Research facilities are available.

Applicants must possess a degree with honours or equivalent qualifications and should have had research and lecturing experience. Experience in gas turbine work will be an advantage.

Salary will be within the range £A2211–£A2561 per annum and commencing rate will be determined according to qualifications and experience.

First-class ship fares to Sydney of the appointee and his family will be paid.

The successful applicant will be eligible, subject to a satisfactory medical report, to contribute to the State Superannuation Fund.

Four copies of applications (including the names of two referees) should be lodged with the Agent General for New South Wales, 56, Strand, London, W.C.2, and a copy forwarded by airmail to the Bursar, University of New South Wales, Box 1, Post Office, Kensington, New South Wales, Australia, before 30th November, 1958. E9069

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19

LECTURER

LECTURER required in January, 1959, to teach Mechanical Engineering subjects to Higher National Certificate level. Applicants should be graduates with suitable teaching and industrial experience. Salary, Burnham Scale, £1200 by £30 to £1350, plus London allowance.

Application form and further particulars may be obtained from the Principal, to whom completed applications should be sent within two weeks of the appearance of this advertisement. E9075

PUBLIC APPOINTMENTS

GOVERNMENT OF NEW ZEALAND

NEW ZEALAND EDUCATION DEPARTMENT

INSPECTOR OF TECHNICAL EDUCATION

The Government of New Zealand invites applications for the position of INSPECTOR OF TECHNICAL EDUCATION.

Duties : To assist in the development of technical education in New Zealand.

The appointment will be made to the Head Office of the Department of Education in Wellington as Assistant to the Superintendent of Technical Education. The appointee will be required to devote a substantial amount of his time to duties connected with the development of courses for technicians in engineering and other fields, and such other work as may from time to time be assigned to him. Headquarters will be in Wellington, but some travelling throughout New Zealand will be necessary.

Qualifications : Applicants should be aged 30 to 45 and be graduates in some branch of engineering with teaching experience gained in technical colleges, preferably in a position of responsibility. Trade experience would be an additional qualification.

Salary : The salary range for the position is from £1290 to £1640 p.a. Commencing salary will depend on experience and qualifications of the applicant and is payable from day of arrival in New Zealand.

For further information apply to the High Commissioner for New Zealand, 415, Strand, London, W.C.2, with whom applications should be lodged as early as possible, as selected candidates will be interviewed not later than 9 December, 1958. In view of this no applications can be considered if received after Wednesday, 26 November, 1958. E9078

UNIVERSITY OF QUEENSLAND, AUSTRALIA

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the above position. Applicants should have a Degree in Engineering, preferably with Honours and experience and interest in the field of Thermodynamics and heat engines. Some industrial and/or academic experience in this field is desirable.

Salary £A1540/£A2040 p.a.

Further particulars and application forms are obtainable from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1, or from the Registrar, University of Queensland, Brisbane, Queensland, Australia.

Applications close, in Australia and London, on 31st December, 1958. E9060

RHODESIA AND NYASALAND

SALISBURY POLYTECHNIC

LECTURER

Applications are invited for the post of LECTURER (Civil Engineering) at the Salisbury Polytechnic.

Applicants should be Civil Engineers with a University degree or its equivalent. They must be prepared to conduct classes for apprentices and for student engineers up to the level of the subjects of Group A of the Part II examination of the Institution of Civil Engineers, London.

Salary Scale : £1300 by £50 to £1750.

One increment is allowed for each year of previous recognised experience up to a maximum of six years.

Service is permanent and pensionable, subject to two years' probation. The passage to the Federation of the selected Lecturer will be paid and half the cost of the passage of his family.

Application forms and further details from : The Secretary (R), Rhodesia House, 429, Strand, London, W.C.2. Closing date, November 14th. E9043

BOROUGH OF EALING

ENGINEER FOREMAN

ENGINEER FOREMAN Misc. VI (£715–£775 inclusive). Skilled engineering fitter, experienced in steam and oil-fired boilers, automatic stokers, kitchen machinery and machine tool repairs.

Full particulars and application form from Borough Surveyor, Town Hall, Ealing, W.5. Closing date 17th November, 1958. E8992

PUBLIC APPOINTMENTS

WOOLWICH POLYTECHNIC, LONDON, S.E.18

ASSISTANT GRADE B IN ELECTRICAL ENGINEERING

Applications invited for an ASSISTANT GRADE B IN ELECTRICAL ENGINEERING. Candidates should have a good Degree and some industrial experience, opportunities for research for a higher Degree for suitable candidates.

Salary within £650–£1200, according to qualifications and experience, plus London allowance of £36–£48.

Particulars and application form from Clerk to Governors, to be returned by 21st November, 1958. E9026

MINISTRY OF SUPPLY

BOSCOMBE DOWN, WILTS

ENGINEERS

Ministry of Supply require ENGINEERS at Boscombe Down, Wilts, to control servicing and inspection of specialised groups of aircraft, including responsibility for non-standard test installations. Qualifications : British of British parents. Recognised engineering apprenticeship. Corporate members of Mechanical or Electrical Engineers, or Associate Fellowship of Royal Aeronautical Society. Considerable experience of aircraft servicing methods essential and recent Service training or background desirable. Similar training on civil aircraft with possession of Air Registration Board Engineers' Licences acceptable. Salary : £1204–£1620 p.a.—Forms from M.L.N.S., Technical and Scientific Register, 26, King Street, London, S.W.1, quoting C709/8A. E9041

CITY OF BRADFORD WATER DEPARTMENT

APPOINTMENT OF ENGINEERING STAFF

Applications are invited for three superannuable appointments ; (a) TWO SENIOR ENGINEERING ASSISTANTS, Grade A.P.T.V. (£1175–£1325) and ; (b) ONE MECHANICAL ENGINEERING ASSISTANT, Grade A.P.T.IV (£1025–£1175).

Candidates for appointments (a) must be Corporate Members of the Institution of Civil Engineers, and for appointment (b) must be Corporate Members of the Institution of Mechanical, Civil or Electrical Engineers.

Candidates for appointments (a) should have a wide experience in water supply, and they will be required for work in connection with the general maintenance of the water undertaking, and particularly in the design and construction of large aqueduct pipe-lines, bridges, culverts, rapid gravity filtration and sedimentation tanks extensions, reservoir construction works, distribution boosters, &c. Appointment (b) covers work on the maintenance and general upkeep of transport, mechanical and electrical plant and equipment.

Applications, stating age, training, professional qualifications and experience, together with the names of two referees, must reach the undersigned by 22nd November, 1958.

Canvassing will disqualify, and an applicant who is related to a member or a senior official of the Council must disclose the fact in his application.

W. H. LEATHEM,
Town Clerk.

Town Hall,
Bradford, 1. E9048

THURROCK URBAN DISTRICT COUNCIL

ENGINEER AND SURVEYOR'S DEPARTMENT

ENGINEERING ASSISTANT

Thurrock Urban District Council (Engineer and Surveyor's Department) require ENGINEERING ASSISTANT. Salary within A.P.T. I/II. i.e. £575–£845 per annum. Candidates should have completed their training in a municipal or civil engineer's office, and have had some subsequent experience. Appointment pensionable. Applications, stating age, qualifications and experience, and quoting three referees to Clerk of the Council, Council Offices, Grays, by 17th November, 1958. Canvassing disqualifies. Relationship with members or senior officer of the Council must be disclosed. E9077

PUBLIC APPOINTMENTS

PORTADOWN BOROUGH COUNCIL

APPOINTMENT OF BOROUGH SURVEYOR

Applications are invited for the position of full-time SURVEYOR to the above Council at a salary within the range £1210 by £45 to £1525 (the commencing point to be in relation to the qualifications and experience of the successful applicant). A car mileage allowance will be payable.

Candidates must be Corporate Members of the Institution of Civil Engineers and/or of the Institution of Municipal Engineers, and must also fulfil the conditions prescribed in S.R.O. 1957/154. Candidates should have considerable experience in Water Works, Sewerage and Sewage Disposal Works, Housing, and Highways, and General Construction.

The appointment will be subject to the approval of the Ministry of Health and Local Government for Northern Ireland, and preference will be given to ex-Service candidates possessing the required qualifications provided that the Council is satisfied that candidates can or within a reasonable time will be able to fill the position efficiently. It is also subject to the provisions of the Local Government (Superannuation) Act N.I.) 1950 and any amendment thereof. The successful candidate will be required to furnish satisfactory evidence of health and take up duty on appointment.

A copy of the Terms and Conditions of Appointment may be obtained on application from the undersigned. Applications stating age, qualifications, experience and particulars of present and past appointments, together with copies of recent testimonials, will be accepted by the undersigned up to 12 noon on Saturday, 29th November, 1958.

The Council will assist in finding housing accommodation for the successful applicant.

GEORGE McGOWAN,
Town Clerk.

Town Hall,
Portadown, N. Ireland.
October, 1958. E9071

ELECTRICAL AND MECHANICAL ENGINEER

GOVERNMENT OF ST. HELENA

ELECTRICAL AND MECHANICAL ENGINEER required by Government of St. Helena for three years in first instance either on probation with prospects of permanency or on contract. Salary £900 a year. Free unfurnished quarters. Free passages for officer and wife and assistance towards children's passages. Liberal leave on full salary. Candidates must be capable of undertaking responsibility for all electrical and mechanical engineering in the Colony, primarily maintenance and control of existing power station which generates a 230-volt L.T. and 3300-volt H.T./A.C. supply distributed mainly by overhead lines from two 112 h.p. and one 25 h.p. Blackstone diesel generators. They must also be able to maintain and control all government vehicles, cranes, and machinery and all staff and labour connected therewith.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/50369/EH. E9042

SOUTHERN RHODESIA GOVERNMENT

DEPARTMENT OF LABOUR

INSPECTOR OF MACHINERY

Vacancy : INSPECTOR OF MACHINERY.

Applicants, under 43, must be qualified engineers in possession of an approved certificate in mechanical or electrical engineering or the Ministry of Transport First Class Marine Engineers Certificate and must have had good all-round experience. The duties will include the inspection of all classes of boilers, elevators and general machinery and previous experience in inspection work of this kind, particularly the inspection and testing of boilers, will be a recommendation.

Salary Scale : £1220 by £50 to £1620.

Application forms and further details from Secretary (R), Rhodesia House, 429, Strand, London, W.C.2. Closing date, December 13. E9044

PUBLIC APPOINTMENTS

DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E9070

PUBLIC APPOINTMENTS

CITY OF LEEDS

WATERWORKS DEPARTMENT

APPOINTMENTS

Applications are invited for the undermentioned appointments :—

(a) ENGINEERING ASSISTANTS (2), A.P.T. Grade III, £845–£1025.

(b) ASSISTANT CHEMIST, A.P.T. Grade II, £725–£845.

Applicants for posts (a) must be Corporate Members of the Institution of Civil Engineers, and have had experience in the design and construction of reinforced concrete water retaining structures and experience in the design and installation of rapid gravity filtration plants and pumping plants will be an advantage.

Applicants for post (b) should have a University Degree in Science or an equivalent qualification. Experience with a water undertaking will be an advantage.

Applications, on forms to be obtained from the undersigned, should be delivered not later than 12 noon on Saturday, 29th November, 1958, appropriately endorsed.

Canvassing disqualifies.

KENNETH L. FORSTER,
General Manager and Engineer.

Waterworks Department,
Civic Hall,
Leeds, 1,
27th October, 1958. E9019

PUBLIC APPOINTMENTS

MINISTRY OF LABOUR AND NATIONAL SERVICE

ROYAL NAVAL SCIENTIFIC SERVICE

APPOINTMENTS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist : MECHANICAL ENGINEER, for work on gas turbine problems in the London area. MECHANICAL ENGINEER for work on design and development of U/W devices in Portland area. METALLURGISTS for Rosyth and Poole. CHEMISTS (Physical and Inorganic), for Poole area, Baldock and London. Candidates must be normally natural born British subjects of natural born British parents, with at least First or Second Class Honours Degrees or equivalent high professional attainments. S.S.O.'s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries : (men) S.S.O. £1190–£1410 ; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A. E8879

TENDERS

COUNTY BOROUGH OF BRIGHTON

WATER DEPARTMENT

MILE OAK PUMPING STATION

CONTRACT NO. 6

STERILISATION PLANT

TENDERS invited for the MANUFACTURE, DELIVERY, ERECTION and SETTING TO WORK of STERILISING EQUIPMENT at the above Pumping Station. Copies of General Conditions of Contract, Drawings, Specification and Form of Tender obtainable from Waterworks Engineer, 12, Bond Street, Brighton, 1. Deposit of £2 2s. 0d. will be refunded on receipt of a bona-fide Tender and return of documents supplied.

Tenders enclosed in plain, sealed envelopes, not bearing any name or mark indicating the sender, and endorsed " Mile Oak, Contract No. 6, Sterilising Plant," must be delivered to me before noon on the 15th December, 1958.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. O. DODD,
Town Clerk.

Town Hall,
Brighton, 1,
23rd October, 1958. E9017

GAL OYA DEVELOPMENT BOARD, CEYLON

TENDER NOTICE

POWER ALCOHOL DISTILLERY

TENDERS are invited for the SUPPLY of a DISTILLERY for processing molasses into power alcohol with a capacity of 2000 gallons of power alcohol per day.

Specifications and conditions of Tender can be obtained from the High Commissioner for Ceylon in the United Kingdom, No. 13, Hyde Park Gardens, London, W.2, or from the Secretary, Gal Oya Development Board, 421, Buller's Road, P.O. Box 524, Colombo 7, Ceylon.

Tenders close on 15th December, 1958, and should be received in Colombo at the address given by that date.

T. C. S. JAVARATNAM,
Secretary,
Gal Oya Development Board.

421, Buller's Road,
Colombo 7,
Ceylon,
20th October, 1958. E9081

SOUTHAMPTON CORPORATION WATERWORKS

SWAYTHLING BOOSTER STATION

CONTRACT NO. 1

TENDERS are invited from manufacturers of centrifugal pumps for the SUPPLY and ERECTION of TWO SETS of Electrically Driven SUPPLY PUMPS, complete with A.C. Motors and other Equipment. (Maximum duty of each set 14,000,000 gallons per day against 90ft. head.)

Specification and conditions may be obtained from the Waterworks Engineer and Manager, Civic Centre, Southampton. Tenders to be submitted to the Town Clerk, Civic Centre, Southampton, by Monday, 15th December, 1958. E9076

TENDERS

BOROUGH OF CHRISTCHURCH

MAIN DRAINAGE

CONTRACT NO. 3—PUMPING PLANT

TO MANUFACTURERS OF CENTRIFUGAL PUMPING PLANT

TENDERS are invited for the MANUFACTURE, SUPPLY and ERECTION of 13 SETS OF VERTICAL and HORIZONTAL UNCHOKEABLE SEWAGE, STORM and SLUDGE PUMPS and ANCILLARY EQUIPMENT. The plant will be contained in 4 pumping stations, as follows :—

Two storm water pumps capable of 340 gallons per minute against 30 feet total head, three activated sludge pumps capable of 340 gallons per minute against 25 feet total head, and two sludge pumps capable of 150 gallons per minute against 29 feet total head. Two sludge pumps capable of 150 gallons per minute against 42 feet total head. Two variable speed sewage pumps capable of a maximum duty of 800 gallons per minute against 42 feet total head, and two sewage pumps rated for 1150 gallons per minute against 28 feet total head. All in accordance with the specification and drawings prepared by the Engineers, Messrs. John Taylor and Sons, Artillery House, Artillery Row, Victoria Street, Westminster, S.W.1.

Copies of the specification and drawings may be obtained from the offices of the Engineers upon payment of £5 (cheque only, made payable to the Borough of Christchurch), which will be returned on receipt of a bona fide Tender not subsequently withdrawn. The contract documents may be inspected at the offices of the Engineers or the Council Offices.

Tenders, in plain, sealed envelopes, endorsed " Pumping Plant—Contract No. 3," are to be delivered to my office on or before noon on 15th December, 1958.

(Signed) J. MACFADYEN,
Town Clerk.

Town Hall,
Christchurch,
Hants. E8982

INDIA SUPPLY MISSION

The Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, D.C., United States of America, invites TENDERS for the following :—

TENDER ENQUIRY NO. SE.10 and SE.14.—For the supply of Heavy Earth Moving Machinery and Ordinary Mining Machinery required for use in Indian Coal Mines, and reverse circulation drills, Diesel Engine driven Trailer, Mounted Arc Welding Generator sets and Tractor Mounted Mobile Cranes, 4-ton Capacity for use in Neyveli Lignite Project.

TENDER ENQUIRY No. SE.10 (SUPPLEMENTARY).—For Reverse Circulation Drills and other ancillary equipment required for use in Neyveli Lignite Project.

Specifications, &c., regarding the above enquiry can be obtained direct from the Co-ordination Department, India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, at £1 1s. 6d. per set. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, D.C., United States of America, so as to reach them by Friday, the 28th November, 1958.

Specimen Copy of the above specification can be seen at India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, under reference S.3820/58/AVH/ENG.2. E9067

INDIA STORE DEPARTMENT

SURFACE GRINDER

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of:

ONE SURFACE GRINDER, Open type, horizontal spindle, working surface of table 56in. by 16in., maximum height admitted 22in.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The applications for Tender forms should state reference 2007/58/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, 5th January, 1959. E9058

FACTORY EXTENSION

EAST MIDLANDS

Heavy engineering firm invites applications for details from FIRMS WISHING to TENDER for the Design and Construction of a 20,000 sq. ft. Factory Extension.

BOX. No. E9029, " The Engineer."

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114

Classified Advts. continued on page 138

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

Professionally qualified engineers are required to be responsible, under a senior engineer, for commissioning reactor experiments in Harwell research reactors ; this involves development and test work and has a direct relation to high flux reactor operation and new reactor technology. Experience in an engineering laboratory and in eliminating functional difficulties with new plant would be helpful.

Salary : between £815 and £1740 (Engineer Class).

Please send a postcard to the Group Recruitment Officer, (1251/25), U.K. A.E.A., Atomic Energy Research Establishment, Harwell, Berks, for details.

E9057

ENGINEERS

FOR WINDSCALE & CALDER WORKS

A number of vacancies exist in the large Engineering Department at Windscale and Calder Works concerned with the maintenance of nuclear reactors and of large-scale and complex chemical plants which present novel and interesting engineering problems. The department is also responsible for construction work associated with modifications to existing plants.

THE POSTS ARE AT FOUR LEVELS :—

(i) GROUP ENGINEERS

responsible to the Works Engineer, for complete aspects of engineering on the Works, including electrical or mechanical. First-class technical knowledge and the ability to control large-scale organisations are required.

(ii) SENIOR ENGINEERS

responsible for the organisation of large sections dealing with mechanical maintenance and modifications to reactors and chemical plants and co-ordinating the work of other engineering sections carrying out maintenance on those plants.

(iii) ENGINEERS (MAIN AND BASIC)

responsible for maintenance of, or modifications to, particular plants. The basic grade offers a first-class opportunity for young engineers to gain valuable experience in a rapidly expanding field.

A recognised engineering apprenticeship and Corporate Membership of a Senior Engineering Institution or equivalent are essential. Candidates will be expected to have had experience in the management of engineering sections, but training will be given in the special techniques applicable to nuclear engineering.

Salaries will be assessed according to qualifications and experience within the ranges :

GROUP ENGINEERS : £2,200–£2,600
ENGINEERS (MAIN) : £1,300–£1,740
SENIOR ENGINEERS : £1,790–£2,080
ENGINEERS (BASIC): £815 (at age 25) –£1,270

Contributory Pension Scheme. There is a staff housing scheme.

Send postcard for application form, quoting reference 2722, to Works Secretary, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, INDUSTRIAL GROUP, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

E9033

CLOSING DATE : 17th NOVEMBER, 1958

EDUCATIONAL

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING, EXHIBITION ROAD, LONDON, S.W.7

ADVANCED ENGINEERING COURSE

MECHANICAL VIBRATIONS

A three weeks', full-time Course of about 45 Lectures and 25 Laboratory or Tutorial Periods, commencing Monday, 5th January, 1959. Emphasis will be given to the application of basic theory to Engineering problems, such as vibration and noise reduction and anti-shock mountings. The theory and practice of dynamic measurement and stress waves in solids will be treated in detail.

Further particulars and enrolment forms can be obtained from the Registrar of the College. Fee : twenty-five guineas. E9052 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A GENERAL MANAGER is required by a Rubber Company specialising in high-grade Mechanical Mouldings, Rubber to Metal Bonding, and a wide range of associated products for the Automobile, Marine, Civil, and Mechanical Engineering Industries. Extensive engineering and factory administrative experience is essential.—Applications should be submitted to the Managing Director, BOX B.181, c/o Streets, 110, Old Broad Street, E.C.2. E8909 A

AN OLD-ESTABLISHED ENGINEERING GROUP, located in North-West England, seeks to engage an ADDITIONAL TECHNICAL REPRESENTATIVE for its heavy engineering division. The man we have in mind should hold a Degree, or its equivalent, in Mechanical Engineering, should be of not more than 33 years of age, and should have spent at least five years in mechanical engineering subsequent to qualifying. He must be prepared for frequent foreign travel, often at short notice. Up to twelve months' training will be given and during this period the salary will be at the rate of £850 per annum. Training will take place both in the United Kingdom and in France. Applications from ex-Officers of the R.E.M.E. or R.N. (Engineering Branch) would be considered.—Replies in confidence to BOX No. E2170, " The Engineer." A

APPLICATIONS ARE INVITED for the following post at Tube Investments Research Laboratories, Hinxton Hall, Cambridge : GRADUATE ENGINEER OR PHYSICIST (or equivalent qualifications) for experimental work on metal forming processes. Previous experience in this field not essential. This post offers excellent opportunities for a man wishing to do basic research, and at the same time gain experience of technical problems in a large and diverse engineering organisation. Ref. E.123

Requests for further details and application form from The Secretary, quoting appropriate reference number.

E9046 A

ASSISTANT ENGINEER, aged 25/30, required to assist Engineer and Buyer. Qualifications B.Sc. or equivalent, with 2 years' student apprenticeship. Duties will include visiting manufacturers' works and may lead to an interesting and well-paid post overseas. Commencing salary in U.K. £1160, plus London allowance according to age and qualifications.—BOX No. E9016, " The Engineer." A

CHEMICAL ENGINEER required for London-based Group of Paint and Synthetic Manufacturers operating throughout the world. Applicants must be fully qualified to plan installation of new plant and plan modifications and extensions of existing processes. Should preferably have previous experience of flowline planning.—BOX No. E9047, " The Engineer." A

CHIEF ENGINEER required, experience in the design of pipe layouts, pressure vessels, heat exchangers, mechanical handling equipment, pumping installations and associated electrics and instrumentation. To be responsible to the Board of Directors for the investigation of industrial projects, appreciation of clients' requirements, and the management of a team of estimators, designer engineers, &c. Salary and conditions are commensurate with the position, with pension and bonus provisions. Please write in the first instance, in confidence.—BOX No. E9039, " The Engineer." A

CHIEF ESTIMATOR required by well-known London Company, engaged on the installation of MECHANICAL SERVICES on industrial projects and building contracts. He will be responsible to a Director for an estimating team and for estimating, specifications, working programme and the solution of procurement problems. Must have had experience of estimating for all kinds of PIPE WORK, PLANT HANDLING AND ERECTION—knowledge of buying an advantage. Salary £1500 p.a. or more according to qualifications, and good conditions of employment.—Application in strict confidence to BOX No. E9037, " The Engineer." A

CIVIL ENGINEER required in Engineering Branch of N.C.B.'s Reconstruction Department in London. Applicants should be Corporate Members of either I.C.E. or I.Struct.E., with at least five years' experience in design and construction of civil engineering and building works. Experience should include structural steel and reinforced concrete practices, general building construction and roads and drainage. Some knowledge of pre-stressed concrete would be an advantage. Appointment (superannuable). Salary according to qualifications and experience, within the range £976 to £1512.—Write for application form to Staff Department (X.1297C), National Coal Board, Hobart House, London, S.W.1, which should be returned by 18th November, 1958. E9065 A

CHIEF ENGINEER

Applications for the post of CHIEF ENGINEER are invited by a Glasgow sugar machinery firm. The Chief Engineer will be responsible for the development, design and performance of the plant and machinery supplied by the company, and will be in charge of the technical personnel engaged on this work. Occasional overseas visits will be required for maintaining contact with sugar factory practice.

Candidates must have a sound engineering background, including a thorough workshop and drawing-office training, followed by practical sugar factory operation for at least six years covering process work and the installation and maintenance of plant. They must possess a flair for machinery design and development, coupled with initiative and administrative ability, as evidenced by experience in senior posts such as Factory Manager of Chief Engineer in a modern sugar factory.

Applicants should possess a Degree in Engineering, or an equivalent qualification. Preferred age 45/55 years.

The appointment is one of high responsibility, for which a commensurate salary will be paid. It will be covered by the Company's contributory Staff Pension and Life Assurance Scheme.

Applications, providing full particulars, to be posted to BOX No. 3101, Wm. Porteous and Co., Glasgow.

E9072 A

CHIEF SURVEYOR required to be responsible for preparation of interim and final accounts for contracts embracing mechanical engineering services and plant installation. Applicants should have had 8–10 years' experience as a senior surveyor, and have proved their ability to manage a surveying department. Good salary and conditions with long-established group of companies.—Interviews can be held in centres throughout England and Scotland and applications should be sent in full confidence.—BOX No. E9040, " The Engineer." A

COLVILLES LIMITED

have openings for first-class DESIGN DRAUGHTSMEN. Steelworks experience not strictly essential if applicant is otherwise fully qualified and adaptable.

Apply by letter to C.M.E. Department, Technical Offices, Motherwell, stating experience and technical qualifications.

E9051 A

CONSULTING ENGINEERS, engaged on varied r.c. and steel structural works, general civil engineering work and foundation problems, require capable DESIGNER/DETAILER. Five-day week and luncheon vouchers.—Apply, Maurice Nachshen and Partners, 58, Victoria Street, London, S.W.1.

E9005 A

DESIGN DRAUGHTSMAN required by Company engaged in manufacture of Civil Engineering equipment. Applicants should preferably have experience in Asphalt Plants ; 5-day week, pension scheme.

Apply in writing, giving full details of education, qualifications, age and experience, to :
BARBER-GREENE OLDING AND CO., LTD.,
HATFIELD,
HERTS.

E9032 A

DRAUGHTSMAN REQUIRED for Structural and General Engineers' Office, fully conversant with the design of steel-framed buildings, roof trusses and fire escapes, references essential.—Lewis and Grundy, New Works, Warser Gate, Nottingham. E2153 A

ENGINEER (MECHANICAL).—Applications are invited from Engineers not over 35 years, who possess First Class M.O.T. Certificates (Steam). Willing to reside in or near London for duties in that area and to undertake three-monthly tours of inspections of boilers, pressure vessels, &c., in West Africa. Salary in accordance with age, previous experience, if any, plus expenses and allowances. Non-contributory pension scheme. Apply in own handwriting.—BOX No. E9056, " The Engineer." A

ENGINEER, qualified, age 28–35, required for technical-commercial work by London firm specialising in materials handling and cement works equipment.—Write details age, experience, salary required, to Secretary, BOX No. E2172, " The Engineer." A

ENGINEER, with considerable design and manufacturing experience, preferably in mechanical handling, required by engineering firm in Midlands, to take charge of works and drawing-office. Remuneration around £2500.—BOX No. E2173, " The Engineer." A

HEAT-TREATMENT SPECIALISTS, well-established Central London, require qualified man capable of contacting firms interested in sub-contract heat-treatment of components. Good opportunities for right man.—Apply, Secretary, Harmax, 72, Brewery Road, London, N.7. NORTH 4451/2. E9022 A

MACHINE TOOL ENGINEER, aged 30/40, required by a small but expanding company producing special precision machine tools, to participate in new fields of development, including machine tool control. Applicants must have good works and design experience, together with a general knowledge of machine tool control systems, and be able to carry responsibility for development of first stages of new products. This opening offers a good opportunity for a man with ability and personality, to fill an important position in an expanding business. The company has a good life assurance and pension scheme and housing assistance could be available for the right applicant.—Write, giving full details of career to date, &c., to BOX No. E2160, " The Engineer." A

MAINTENANCE ENGINEER/FITTER required with good working knowledge of Motor Vehicles. Age between 30 and 40. Good references. Good salary.—Apply : Wendell Park Products, Ltd., 20, Wendell Road, Shepherds Bush, W.12. E2169 A

INSTRUMENTATION ENGINEER

British Nylon Spinners invite applications for a Graduate in Mechanical or Electrical Engineering, to fill a vacancy in their Head Office.

Candidates, between 28–35 years of age, should have had experience in the investigation, design and application of industrial instrumentation, including pneumatic and electrical control gear.

This appointment, in an expanding and stable industry, offers a progressive and satisfying career to a man who is keen to apply his knowledge to design and installation problems and to follow a project through to its completion.

Prospects are good, whilst progress is carefully watched. A contributory pension scheme is in operation, houses may be rented and removal expenses assisted.

Selected applicants will be invited to visit the Company, which is attractively situated, for a personal discussion.

Applications, quoting Ref. 27, should be made to :—

The Personnel Manager,
British Nylon Spinners, Ltd.,
Pontypool, Monmouthshire.

E9014 A

MONSANTO CHEMICALS, LIMITED, require a SERVICES ENGINEER to work under the Company's Services Engineer in the development of major services plant installations. Candidates will be expected to assist in the carrying out of initial study work, design and design calculations, plant specifications, preparation of economic evaluations and reports, supervision of design staff and contractors on steam generation, water cooling, and compressed air plant and factory distribution systems. The work will be varied and interesting, and will involve some individual investigations and liaison with works' staffs on any particular project. Candidates, preferably aged about thirty-three years, should be qualified to A.M.I.Mech.E. standard and have a minimum of three years' experience in a position of responsibility on work similar to that described above. The post is based on London, but will involve visits to the Company's factories at Ruabon, Newport and Fawley of varying duration.

Salary commensurate with qualifications and experience ; non-contributory pension scheme. —Full particulars of age, qualifications and experience should be sent to Personnel Department DL094, Monsanto Chemicals, Limited, Monsanto House, 10/18, Victoria Street, London, S.W.1.

E9053 A

OPERATING ENGINEERS for high-pressure water tube boilers required by well-known firm of Boiler Contractors. Applicants must have previous experience and be prepared to travel anywhere in the U.K. Minimum qualifications B.O.T. Certificate (Steam). Membership Institute of Marine Engineers of H.N.C. an advantage. Salary commensurate with experience and qualifications. Pension Scheme. Apply, giving full details of age, previous employment and qualifications in confidence.—BOX No. E8967, " The Engineer." A

PIPE WORK DESIGN DRAUGHTSMEN required by BRITISH NYLON SPINNERS, LIMITED. Applicants must be familiar with steam, water and gas services and preferably some knowledge of chemical engineering process pipe work. Applicants should have qualifications of Higher National Certificate plus some other experience of this type of work. The vacancies are permanent and pensionable. The location of the appointment is in modern surroundings in rural Monmouthshire but within three hours' travelling distance of London. Houses may be available to rent in the neighbourhood and generous allowances are made towards cost of moving.—Apply in writing, quoting reference E.145, to Personnel Manager, Pontypool, Monmouthshire. E9062 A

REQUIRED, FOR THE SOUTHERN RAILWAY OF PERU, DIESEL ENGINEER (OPERATION). Candidate must have served apprenticeship in a general mechanical engineering workshop and have had at least 3 years' subsequent experience on diesel engines. Education required up to at least the Ordinary National Certificate standard in Mechanical Engineering. Candidate should not be more than 40 years of age. Salary offered £1400–£1600 per annum, according to age and qualifications.—Please apply in writing to PERUVIAN TRANSPORT PURCHASING COMPANY, LIMITED, Rex House, 38, King William Street, London, E.C.4. E9080 A

SENIOR MECHANICAL HANDLING DESIGNERS required in Bristol. Experience of colliery equipment, creepers, tipplers, &c., desirable. Salary £950–£1150 p.a.—BOX No. E9073, " The Engineer." A

TECHNICAL REPRESENTATIVE in connection with hire of large cranes and associated services. Some heavy mechanical engineering experience, including drawing-office work and a successful period as salesman or technical representative in similar work essential. Salary plus commission to commence, not less £900, with ample opportunity for improvement.—BOX No. E9054, " The Engineer." A

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED

require an

ASSISTANT ENGINEER

to fill a vacancy on the staff of their Ayr Fertiliser Works. The minimum qualifications required are a Higher National Certificate in Mechanical Engineering, but preference will be given to candidates with an Engineering Degree or A.M.I.Mech.E. Experience of plant installation and maintenance will be essential.

The post is permanent and pensionable and the commencing salary will be according to age, qualifications and experience. Application forms will be forwarded to suitable candidates on receipt of brief details covering age, qualifications and experience, which should be addressed to the

Personnel Officer, Scottish Agricultural Industries Limited, 39, Palmerston Place, Edinburgh, 12, quoting Reference 25/Assistant Engineer, to reach him not later than 14th November.

E9062 A

TRANSLATOR REQUIRED for translation of Russian technical periodicals, books, &c. Sound knowledge of mechanical or production engineering. This is a key position in a rapidly expanding organisation in the East Midlands. Excellent prospects of advancement, working conditions, and superannuation scheme.—Send full details to the Secretary, PRODUCTION ENGINEERING RESEARCH ASSOCIATION, Melton Mowbray, Leics.

E9066 A

WANTED : DRAUGHTSMAN, 25 to 35 years, to assist in the development of shell, including packaged type, boilers. Knowledge of pressure vessels an advantage. Write, giving details, also salary,—BOX No. E2157, " The Engineer." A

ELECTRICAL ENGINEER

wanted by leading German manufacturer for German-English translations. Applications are invited from British-trained engineers with a good general education and sound technical training, preferably also with practical experience in the application of electric equipment. Good working knowledge of German is essential. The ability to write clearly and concisely will be expected of candidates. A five-day week is worked with generous holidays. Favourable housing conditions for permanent staff.—Apply, stating age, education, qualifications, experience and salary required, to BOX No. E9064, " The Engineer."

A

A vacancy occurs in a Birmingham firm for a

DEVELOPMENT ENGINEER

between 25 and 55 years old, possessing a degree or Higher National Certificate in Mechanical Engineering, and capable of working with a minimum of supervision. Salary £800 to £1000, non-contributory pension and profit sharing schemes. For further information please contact :

Birmingham Productivity Association Technical Advisory Service Limited, 95, New Street, Birmingham, 2, quoting ref. 453/DE. TEL.: MID 0912.

E9028 A

SITUATIONS VACANT

BABCOCK & WILCOX, LIMITED

require two

MECHANICAL OR STRUCTURAL ENGINEERS

for Design Work on
Special Pressure Vessels
and
Stress Analysis Problems
in their
ATOMIC ENERGY DEPARTMENT

in London.

Write, giving details of qualifications and experience, to :—

The Assistant Secretary,
BABCOCK & WILCOX, LTD.,
209, Euston Road,
LONDON, N.W.1.

E9024 A

SITUATIONS VACANT

THE BRITISH STEEL PILING CO., LTD.

requires a

TECHNICAL WRITER

for the preparation and revision of the Company's publications, providing technical information for its distributors in Britain and overseas, and assisting the Company's advertising agents with copy for advertisements in technical journals.

Applicants must have a facility for writing clearly and concisely on technical subjects and should have some mechanical or civil engineering training. Experience of civil engineering contractors' plant would be an advantage. The appointment, which will commence with a period of training, is permanent and pensionable.

Apply in writing only, stating age and qualifications, and giving an indication of salary required, to the Company at 10, Haymarket, London, S.W.1, marking the envelope "Technical Writer."

E9045 A

SITUATIONS VACANT

CHEMICAL ENGINEERS

REFINERY PROCESS ENGINEERING BAHRAIN

The Bahrain Petroleum Company, Limited, invites applications for a position in their Research and Development Department from qualified Chemical Engineers under 30 years of age, with two or more years' experience in work connected with the evaluation of process performance, process and quality control, technical planning and process improvement in oil refineries or other heavy chemical plants.

A good commencing salary can be offered in accordance with qualifications and experience in addition to which housing is provided together with an allowance which covers meal costs. Recreational facilities are ample and the Company has Pension and Provident Fund schemes and grants paid home and local leaves. A kit allowance is given and medical attention provided.—Apply in writing, quoting "RD," with full particulars, to Caltex Services, Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E9050 A

SITUATIONS VACANT

BRITISH OXYGEN WIMPEY LIMITED

require

INSPECTION ENGINEERS

to be based on a site in Cumberland for Survey of site fabrications, including Class (1) Vessels, Class (A) Welding of pipe lines, stainless steel materials, &c.

Progressive appointments on permanent staff, with good commencing salary and contributory Pension Scheme. Only first-class men with several years' Inspection experience and Ministry of Transport 1st Class Certificate or equivalent need apply.

Reply with details of age, experience, qualifications and present salary, to :

Office Manager,
BRITISH OXYGEN WIMPEY LIMITED,
17, Monck Street, London, S.W.1. E9038 A

ENGINEER (SENIOR GRADE)

required by the

ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS

to supervise a section engaged on the planning, design, estimating and commissioning of a wide variety of buildings, process plants and services.

Corporate Membership of a Senior Engineering Institution and considerable experience in the planning and design of works services for process plants is required. A knowledge of the hazards arising from radio-active and chemical working will be an advantage.

SALARY : £1,790—£2,080

Contributory Superannuation Scheme. A modern house with garage or, alternatively, substantial assistance in house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. A1883/25.

E9034 A

CHIEF INSPECTOR

Applications are invited for the post of CHIEF INSPECTOR in the C.V.A. Group of factories. These factories are in Sussex and are concerned mainly with the manufacture of high quality Machine Tools. The post involves the direction and control of the existing Inspection Department and the introduction of quality control techniques. Candidates should be between 37 and 45 years of age with a First Class Engineering background, and have at least 10 years experience in an Inspection Department in a comparable industry.

This is a senior appointment and carries a substantial salary. A car will be provided and an excellent Pension Scheme operates. Existing personnel know of this advertisement.—Write in the first place for further details and standard application form to : Vice-President, Industrial Relations, C.V.A. Group, Portland Road, Hove, Sussex.

E9055 A

MECHANICAL DESIGN ENGINEER

The Associated Ethyl Company, Limited, has a vacancy in its Engineering Department at Ellesmere Port for a Mechanical Design Engineer.

Applicants must have served a recognised trade apprenticeship followed by drawing-office experience, and should be Corporate Members of the Institution of Mechanical Engineers. They must have had 5 or more years' appropriate experience, preferably in the chemical or petroleum industries.

This is a young and vigorous Company offering opportunities of advancement to men of ability and initiative.

Applications, giving full details, should be sent to :
Manager, Staff and Training Department,
ASSOCIATED ETHYL COMPANY, LIMITED,
Ellesmere Port, Cheshire.

E9063 A

GRADUATE MECHANICAL ENGINEER

THOMAS HEDLEY AND CO. LIMITED,

LONDON MANCHESTER NEWCASTLE

Continuing company growth has created two opportunities for young Graduate Mechanical Engineers. It is anticipated that similar vacancies will be available in the first half of next year and interested graduates available then are invited to consider them now.

The engineering work of the company ranges from the development, design and construction of new buildings and equipment to the management of people and the administration of engineering work in our factories. The technical fields covered include fluid mixing and pumping, mechanical and pneumatic conveying, pressure and vacuum vessels, heat transfer, automatic process control, high-speed automatic machinery and the provision of steam, electricity, gas, compressed air, and refrigeration capacity.

We recognise that the engineering graduate entering industry may not have a clear appreciation of the eventual field which will interest him. We aim to provide him with the opportunity to occupy several different positions of responsibility during his first few years and later help him to decide the final direction a progressive career should take.

As the company is staffed entirely by promotion from within, we are selective in the people we employ and devote considerable attention to their personal development. The new man is given individual training to prepare him for his first and each succeeding assignment, and this is followed by personal coaching by his superior. Starting salaries are attractive and increments are by merit. Removal and travel expenses and assistance with initial accommodation are provided by the company, along with other benefits, such as Superannuation, free Life Assurance, &c.

If you have a good degree in mechanical engineering, are not more than 27 years of age, and would like to know more about these appointments, we invite you to write, in confidence, including an outline of your qualifications and experience, to :—

The Chief Engineer,
Thomas Hedley and Co., Limited,
Gosforth,
Newcastle upon Tyne.

E8978 A

RHOKANA CORPORATION LIMITED NORTHERN RHODESIA

VACANCIES FOR SECTIONAL ENGINEERS

The following vacancies exist for Sectional Engineers in Northern Rhodesia :

1. SECTIONAL ENGINEER—not less than 28 years of age, who has had at least two years' experience as an underground engineer on a large mine. Must hold an Engineering Degree or degree equivalent in Mechanical or Electrical Engineering.
   Salary : depending on experience but not less than £1706 per annum.
2. SECTIONAL ENGINEER—not less than 30 years of age, who has had at least five years' experience on operations and/or maintenance in a large thermal power station. Must hold a degree or degree equivalent in Mechanical or Electrical Engineering.
   Salary : depending on experience but not less than £1646 per annum.
3. SECTIONAL ENGINEER—Electrical—not less than 25 years of age. Must hold a Degree in Electrical Engineering. General experience in testing and commissioning industrial equipment will be a recommendation.
   Salary : depending on experience but not less than £1646 per annum.
4. SECTIONAL ENGINEER—not less than 28 years of age who has had at least five years' experience on maintenance work in mines, steelworks, railways or heavy industry. Must hold a degree or degree equivalent in Mechanical Engineering.
   Salary : depending on experience but not less than £1646 per annum.

For all the above positions married accommodation (basically furnished) will be available immediately at a rental of £5 per month.

There is a variable cost-of-living allowance at present about £5 per month.

Free life assurance is provided and there is a contributory pension scheme. There is also a fluctuating bonus based on the price of copper.

Leave is at the rate of 51 days per annum, accumulative up to 153 days.

Applications, giving full details of qualifications and experience and marital status should be sent to :—

Rhokana Corporation Limited,
40, Holborn Viaduct,
London, E.C.1.

The positions shown in the advertisement are numbered 1 to 4 and applications should indicate, by number, for which post application is being made. E9036 A

THE GLACIER METAL CO. LTD.

Applications are Invited for the Post of

UNIT MANAGER

The Unit Manager will be in charge of the Thick Wall Unit, one of the three major production units in the Company's No. 1 Factory in London, and will be solely responsible to the Factory General Manager.

The Thick Wall Unit, consisting of some 350 members, manufactures a wide range of heavy types of engine half bearings, together with bushes and cast bars, and carries out some final machining of other products. The work is predominantly skilled, batch production and mainly machining, but die-casting and other processes are carried out as well.

The Unit Manager has six Section Managers in charge of individual machine shops wholly responsible to him. In addition, he has his own specialist staff of engineers and production controllers. Within a policy set by the General Manager he is responsible for carrying out a production programme and meeting output, cost, delivery and quality standards. He is left to judge how best to maintain and develop his plant, engineering methods, people and organisation, so that the Unit is geared to meet both its present operational task and, through technical progress, to respond with increasing effectiveness, to the demands made on it in the future.

Candidates should be technically qualified, preferably, though not essentially, to degree level, and should have had responsibility for man management and experience connected with machine shop production. Preferred age range 30-45, though exceptional candidates outside this will be considered. A younger candidate would be expected to warrant eventual promotion to General Manager. The post might appeal to, among others, technically qualified officers leaving the armed services.

SALARY RANGE £1800-£2550
per annum

Applications, which will be treated in strict confidence, should be sent to :—

Personnel Director (Ref. UMT),
GLACIER METAL CO. LTD.,
Ealing Road, Alperton,
Wembley, Middx.

E9052 A

Classified Advts. continued on page 140

SITUATIONS VACANT

GENERAL ELECTRIC COMPANY LIMITED
ATOMIC ENERGY DIVISION

CIVIL, MECHANICAL AND ELECTRICAL SENIOR SITE ENGINEERS

Applications are invited from Engineers to supervise the construction of Atomic Power Stations.

Applicants should have had previous experience on large construction projects and a Degree or Membership of one of the Senior Institutions is desirable.

These positions, which are permanent and pensionable, give opportunity to those able and willing, for consideration for posts of high responsibility and appropriate remuneration.

Application, giving full details of qualifications and experience, should be made to : Personnel Manager (D.W.T.A.),

THE GENERAL ELECTRIC CO., LTD., FRASER AND CHALMERS ENGINEERING WORKS, ERITH, KENT.

E9074 A

SITUATIONS WANTED

ENGINEER (33), seeks responsible position. Conscientious, reliable and adaptable. B.Sc. (Eng.). A.M.I.Mech.E., A.M.I.W.M. Apprenticeship, 7 years. Design, 6 years Works Management, medium and heavy mechanical engineering. Present salary £1420 p.a.—BOX No. E2174, "The Engineer." B

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone SLOane 5259). E103 E

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERrard 9953). Catalogue on request. E128 E

DRAWING & DESIGN SERVICE

SALES BROCHURES AND INSTRUCTION MANUALS, &c. Complete production service, including Design, Copy, Illustration and Printing. Specialists in Engineering Publicity.—Kingsgate Advertising, 71, Kingsgate Road, London, N.W.6. Telephone : MAIda Vale 8297. E141 S

BUSINESS OPPORTUNITIES

£500,000 AVAILABLE

to purchase an old-established Business in any Trade.

Present Management can remain.

Write in confidence to :

REGINALD TERRELL,
BUSINESS BROKERS LTD.
46, St. James's Place, London, S.W.1.
(HYD 1678)

E8764 G

PATENTS

THE PROPRIETORS of British Patents Nos. 662,317 for "PERCUSSION MECHANISM FOR MORTARS, BOMB-THROWERS AND SIMILAR FIREARMS," 738,727 for "IMPROVEMENTS IN AND RELATING TO BASE PLATE FOR MORTARS AND LIKE APPARATUSES," 753,838 for "IMPROVEMENTS IN AND RELATING TO A FIN ARRANGEMENT FOR A PROJECTILE" and 760,905 for "IMPROVEMENTS IN AND RELATING TO A FUSE FOR A PROJECTILE AND APPLICATIONS THEREOF," desire to enter into negotiations with a firm or firms for the sale of the patents or for the grant of licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E9068 H

MISCELLANEOUS

A NEW RADIOGRAPHIC INSPECTION SERVICE.—GAMMAX, LTD., non-destructive testing specialists, provide Site or Laboratory, Radiographic Service. Manufacturers and suppliers of gamma and X-ray equipment and accessories.—GAMMAX, LTD., Cecil House, 47–51, Wharfdale Road, London, N.1. TER 0677–8 and 6925. E137 I

MISCELLANEOUS

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157–159, Borough High Street, London, S.E.1. E110 I

SUB-CONTRACTING

ACCURATE MACHINING

also on Models and Prototypes, &c.
MILLING **TURNING**
JIG BORING **PLANING**
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING
GIVE US YOUR DIFFICULT JOBS
LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075. E115 MW

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved, —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

HEAT TREATMENT in all its branches, A.I.D. A.R.B. and I.E.M.E. approved.—Harmaxs Heat Treatments, Ltd., 72, Brewery Road, London, N.7. NORTH 4451/2. E9023 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

MANUFACTURING CAPACITY AVAILABLE IN EAST MIDLANDS

Medium heavy engineering works has following facilities available :
- Fabrication and welding up to 5 tons.
- Guillotines up to 6ft. by ¼in.
- Press brakes up to 10ft. by ¼in.
- Planers up to 20ft. by 6ft. 6in by 3ft. 0in.
- Vertical borers up to 6ft. dia.
- Horizontal borers up to 5⅛in. spindle.
- Ward Combination and Capstan Lathes up to No. 13.
- Radial Drills up to 6ft.
- Millers, Plain Cylindrical Grinders, &c.

Fitting Shop for complete assemblies of units up to 15 tons.
Manufacture and assembly of complete units undertaken. For complete capacity sheet write BOX No E2171, "The Engineer." MW

MACHINERY Etc. WANTED

LEBOND HEAVY-DUTY DEEP-HOLE BORING MACHINE, capacity approx. 20in. dia. by 16ft. boring length.—BOX No. E9079, "The Engineer." F

FOR SALE

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Adamson, standard cab control, 42ft. 3in. span, 400/3/50.
40-ton Clyde, 42ft. 3in. span, with 20-ton aux., unused.
30-ton Adamson, 42ft. 3in. span, 5-ton aux. ; new in cases.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
20-ton King, 42ft. 3in. span, unused.
10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

FRED WATKINS (ENGINEERING) LTD., COLEFORD, GLOS.
Tel. : Coleford 2271/2/3. E132 G

NEW MITCHELL LATHE

14¼in. centre by 16ft. bed, admit 9ft. 9in. between centres, hollow spindle 4¼in. diameter, swing in gap 52in. diameter by 17in. wide.

F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.

E9035 G

NO. 23 COCHRAN BOILER 105 lbs. W/P. 6030/8050 lbs. per hr. evap. complete with mountings and feed pump for immediate delivery from stock.

ABELSON AND CO. (ENGINEERS), LTD., Coventry Road, Sheldon, Birmingham, 26.
SHELdon 2424. E8926 G

FOR SALE

SERVICE EDWARDS VALUE!

NEW BESCO 8ft. 4in. by 3/16in., Type HK, All-Steel Undercrank Open-Ended Production Power Guillotine of all-steel construction, arranged motor drive for 400/440/3/50, length of blades 110¼in., capacity 3/16in., gap in side frames 3½in., strokes per minute 54.
INCANDESCENT Forced Draft Bar Heating Furnace, double ended, gas fitted, heating chamber 36in. wide by 24in. deep by 9in. high, total length through furnace 32in. working, temperature range 900 deg. to 1350 deg. C.; 1200 deg. C. can be reached in about 1½ hours after starting from cold.
QUICKWORK No. 321, Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. dia. Weight approximately 18 cwt.
JOHN HANDS Double-Sided Friction Screw Press, arranged motor drive, for 400/440/3/50, fitted with Broughton automatic press guard, pressure exerted approximately 60 tons, maximum stroke 18in., between uprights 37½in., tee-slotted bed 36in. by 46in.
BLISS No. 1 Double-Sided, Double-Action, Geared Toggle Drawing Press, arranged for belt drive, punch stroke 7in., blankholder stroke 4½in., between uprights 17in., size of bed 16in. by 18⅜in., hole in bed 6¼in. diameter.
CRAIG and DONALD Model 400/10, All-Steel, Motorised, Double-Geared Press Brake of steel plate construction, arranged motor drive for 440/3/50, pressure exerted approximately 400 tons, former capacity 10ft. by ¾in., width between side frames 82in., stroke approximately 4in.
Photographs of the above are available.

MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
Telephone : EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

FOR SALE

5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.
5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane, 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super pet./elec. Mobile Crane on solid rubber tyres.
6-ton Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
¾ cu. yd. Rapier 423 diesel-driven Excavator with shovel equipment.
1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.

WILLIAM G. SEARCH, LIMITED,
WHITEHALL ROAD, LEEDS, 12.
Tel.: 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel.: Simonswood 3361 (5 lines).

E8923 G

FOR SALE

5340-ton HYDRAULIC RUBBER DIE PRESS by John Shaw, rubber pad 6ft. by 4ft., with self-contained Pumping Equipment.
2000-ton HYDRAULIC FORMING AND DRAWING PRESS, die cushion, 12ft. 6in. by 7ft. 6in., with self-contained Pumping Unit.
800-ton HYDRAULIC FLANGING PRESS by Hydraulik, Duisberg, 3 main rams, 4 vicing rams, table 16ft. dia., daylight 10ft.
500-ton HORIZONTAL EXTRUSION PRESS for sections with self-contained oil Pumping Unit.

ABOVE ARE SELECTED ITEMS FROM OUR LARGE STOCK OF HEAVY PRESSES.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6.

E8980 G

DIESEL/ALTERNATOR SET

Comprising : Gardener 5 cylinder L.W. Diesel Engine driving 3-phase 4-wire Alternator rated 50 kVA at 400 volt, Belt Driven Exciter. Automatic Voltage Control, 60 amp TP Switch, 3 Ammeters, Switched Voltmeter.—Apply : H. W. Nevill, Ltd., Acton Lane, Acton, W.3. Tel. : ACO 0014. E2165 G

GAS PRODUCER PLANT for sale, complete with all accessories. Capacity 300,000 cubic feet per hour. Inspection invited by appointment with:

TUBES (EQUIPMENT), LTD.,
Broadwell Works,
Oldbury, Nr. Birmingham. E2164 G

FOR SALE

1 DIESEL GENERATOR, 55kW., 400V., 3 Phase, 50 cycles, with Tropical Radiator by McLaren. Type M4, Mark II. "Brush." Purchased 1951.
Further particulars.—BOX No. E2168, "The Engineer." G

FOR SALE

SOAG

OFFER AT ATTRACTIVE PRICES
HIGH CLASS
HORIZONTAL BORERS
FROM STOCK

KEARNS No. 4 Patent type, 4in. spindle, verniers, main table 42in. by 66in., distance 7ft. 6in.
KEARNS No. 3 Patent type, 3¼in. spindle, covered bed, table 32in. by 60in., verniers, screwcutting, in progress of reconditioning.
RICHARDS HB.2, 2¾in. spindle, table 39in. by 30in., verniers, screwcutting, fully reconditioned and ready.
PEARN RICHARDS No. 4 standard type, facing head only, table 60in. by 36in., older machine but in good condition.

IT'S CHEAPER TO BUY NOW.

We specialise in rebuilding the heavier types of machine tools and would welcome your enquiries.

SOAG MACHINE TOOLS, LTD.,
JUXON STREET,
LAMBETH, LONDON, S.E.11.
'Phone : RELiance 7201.
'Grams : Sotoolsag, London, S.E.11.

E213 G

METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.

Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.
Newport, Mon.
Tel. : Newport 66941 (6 lines).

E120 G

BALANCER, strobo-dynamic, capacity 5–1000 lb., accommodating any type test rotor ; latest electronic instrumentation, low price, as new, inspection.—Giesler Ltd., River Place, Essex Road, London, N.1. 'Phone : CANonbury 5604. E9049 G

SPECIAL OFFER!
FOR IMMEDIATE DISPOSAL
3 VIRTUALLY NEW

OVERHEAD TRAVELLING CRANES

by VAUGHAN

Manufactured late 1954/early 1955, arranged for Floor Control.

Capacity	**7 TON**
Span	**48′ 0″**
Height of Lift	**30′ 0″**
Lifting Speed	**20′ 0″ f.p.m.**
Traverse Speed	**100′ 0″ f.p.m.**
Long Travel	**150′ 0″ f.p.m.**

Electric Supply 440/3/50 A.C. Motors by Laurence Scott, Control Gear by Allen West.

GEORGE COHEN
Sons & Company Limited
WOOD LANE, LONDON, W.12
Telephone : Shepherds Bush 2070
E277 G

THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD

AUCTIONEERS & VALUERS

JOHN FOORD & COMPANY

VALUERS AND ASSESSORS

OF WORKS, FACTORIES ENGINEERING PLANT AND MACHINERY

56, VICTORIA STREET, LONDON, S.W.1.

VICTORIA 2002/3/4

Established Over a Century

AUCTIONEERS & VALUERS

HENRY BUTCHER AND CO.

Auctioneers, Valuers and Surveyors

Specialising in the

SALE & VALUATION

of

ENGINEERING & ALLIED WORKS PLANT & MACHINERY

73, Chancery Lane, London, W.C.2.

HOLBORN 8411 (8 lines)

AUCTIONEERS & VALUERS

Established 1807

FULLER, HORSEY SONS & CASSELL

Specialists

IN THE

SALE & VALUATION

OF

WORKS and MANUFACTORIES ENGINEERING PLANT and MACHINERY

10, LLOYD'S AVENUE, LONDON, E.C.3.

Telephone : ROYAL 4861

AUCTIONEERS & VALUERS

Established 1850

WHEATLEY KIRK PRICE & CO.

F. L. JUDSON, F.R.I.C.S., F.A.I.
E. BEDDARD, A.I.MECH.E., F.A.I.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.I.P.A.

SURVEYORS, VALUERS and AUCTIONEERS of FACTORIES, PLANT and MACHINERY

FIRE LOSS ASSESSORS

9, REX PLACE, LONDON, W.1.

Telephone : HYDE PARK 8844/5/6 (3 lines)

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Broomwade 400, 300, 200, and 130 cu. ft. ; all motorised ; Reavell Rotary Blowers, 2000 c.f.m., 3-2 p.s.i.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib ; 6-ton and 4-ton Coles Diesel-Electric ; 3-ton Jones Super 40 (3) ; Neals 2-ton Diesel, 20ft. jibs (2) ; Derrick, 10-ton Henderson Steam, 120ft. jib ; 5-ton Wilson Electric, 70ft. jib ; Steam Loco, 18-ton Brownhoist, 50ft. jib ; 10-ton Coles, 40ft. jib ; 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib ; 5-ton Cowans Sheldon, 50ft. jib ; 5-ton Grafton, 38ft. jib ; E.O.T. 40-ton Adamson, 42ft. span ; 20-ton Vaughan, 42ft. span (8) ; Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris ; 5-ton Henderson, 24ft. 7½in. span, 1946 ; 5-ton King, 29ft. 3in. span ; 2-ton Morris, 18ft. span ; 2-ton Smith, 34ft. span.
LOCOS.—Fowler Diesel, 150 h.p. (2) ; Ruston Diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil fired, one coal ; Peckett Steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in. black new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ½in. ; Robertson Straightening Rolls, 8ft. 6in. by ½in. ; Berry Bending Rolls, 7ft. by ½in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ⅝in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14-ton Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; Bigwood geared Bending and Straightening Machine up to 8in. by 6in. R.S. Joists ; two 40kVA Spot Welding Machines ; Wire drawing machine, 3 die, up to ⅜in. copper ; 50kW Electric Furnace, 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

FOR SALE

One Sand Clarifier Plant and Disintegrator, by Foundry Equipment, Ltd.
One Coremaking Machine, by Fordath, Ltd.
One Sand Mixer, Model C.A., by Fordath, Ltd.
One Moulding Machine, Jolt Squeeze, A.T.2. by British Moulding Machines, Ltd.
One Moulding Machine Jolt Squeeze, A.T.4, by British Moulding Machines, Ltd.
All in excellent mechanical condition.
Various Sterling Moulding Boxes, 20in. by 15in. by 3in., by 5in. and 7in., and 32in. by 16in. by 8in.

Apply : H. AND E. LINTOTT, LTD., Engineering Works, Foundry Lane, Horsham, Sussex. E2148 G

TWO BELLISS & MORCOM 2500 C.F.M. COMPRESSORS. 100 lb. w.p., 550 h.p. motors, 6600/3/50 supply. Used 4 years only. With Inter. and Aftercoolers, Receiver, Switchpanel. Available immediately.—FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. 'Phone : Coleford 2271/2/3. E139 G

ESTABLISHED 1877

LEOPOLD FARMER & SONS

conduct

AUCTION SALES and VALUATIONS

OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES

FACTORY INVESTMENTS

MORTGAGES ARRANGED

46, GRESHAM STREET, LONDON, E.C.2.

Telephone : Monarch 3422 (8 lines Telegrams : Sites, Londo

FOR SALE

600

875kVA., 6·6kV., 3/50 pass-out condensing Steam Turbo-Alternator Set by FRASER & CHALMERS/G.E.C., steam pressure 180 p.s.i., 420 deg. Fah. temp., pass-out up to 10,000 lb./hour at 30 lb. pressure, with condensing equipment and control gear.
675kW., 400/3/50, 4-wire back pressure type Steam Turbo-Alternator Set by BELLISS & MORCOM/BRUSH ELECTRICAL, steam pressure 150 p.s.i., 12 lb. back pressure, with standard ancillaries and Alternator control gear.
400kW., 440/3/50, 4-wire Diesel Alternator Set : speed 375 r.p.m., incorporating 675 h.p. oil engine by W. H. ALLEN coupled to English Electric Alternator with control gear.
1000 c.f.m. ALLEY & MACLELLAN vertical single-stage Air Compressor, 50 p.s.i., direct coupled to 160 h.p. CROMPTON PARKINSON auto-synchronous motor, 400/3/50, with control gear.
2225 c.f.m. BELLISS & MORCOM vertical 2-stage Air Compressor, 100 p.s.i., 223 r.p.m., coupled to 500 h.p. CROMPTON PARKINSON slipring motor, 3000/3/50 with Starter.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E200 G

COOLING TOWER

Capable of absorbing equivalent of 330 h.p.; rectangular, open type, wood construction, 14ft. by 10ft. by 18ft., complete with all necessary fittings. Never erected and un-used.
Apply : Cammell Laird and Co. (Shipbuilders and Engineers) Limited, Birkenhead. E2167 G

FOR SALE, Sigmund Pumps, types SQL.10, 16in. suction, 14in. discharge, capacity 3250 gallons per minute at 230ft. head. Reconditioned ; 2 sets available.—R. S. Hayes, Ltd., Bridgend, Glam organ. Tel. No.: 1311 (3 lines). E9059 G

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
November 12	Miscellaneous stores.	15 C.E.S.D., Arncott, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel. : 73.)
November 17-21	Vehicles, lifting and earth moving equipment including :—	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. : 47271.)
	Saloons and estate cars (Porsche type "356" and 44 Morris Minors, Ford Anglias and Populars), Jeeps, landrovers, utilities, tankers, mobile fitted workshops, light and heavy trucks and vans, trailers, mobile cranes, tractors, bulldozers and angle-dozers (including 46 Caterpillar D.8s, D.7s and D.4s, and 57 International T.D.18s.), dumpers, macadam and concrete mixers, powered scrapers and graders, road rollers, excavators, rooters, fork lift trucks, plant ancillaries and spares, motor cycles, vehicle washing plants, batteries, tyres, &c.		
November 27	Miscellaneous stores, including batteries, tyres, binoculars, sandbags, &c.	M.O.S. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept L), 20, King Street, Hereford. (Tel. : 4366.)
December 2	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Byley, Middlewich, Cheshire. (Sale at New Islington Public Hall, Ancoats, Manchester.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel. : Blackfriars 8373.)
December 5	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester.	FENN, WRIGHT & CO. (Dept. L), 146, High Street, Colchester, Essex. (Tel. : 3171.)
December 9	Miscellaneous stores.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. : 47271.)

SALES BY TENDER

Horizontal borers, horizontal and vertical millers, engraving, slotting and shaping machines, capstan, turret and centre lathes, radial and pillar drills, &c., located at Cardiff.
Tenders to be submitted by December 8.

APPLICATIONS (*a*) for catalogues for the auction sales should be made *only* to the auctioneers shown above (price of catalogues 1s.—P.O. only).
(*b*) for Tender Forms should be made to the Ministry of Supply, Directorate of Disposals, First Avenue House, High Holborn, London, W.C.1.

E118 J

FOR SALE

HYDRAULIC PRESSES
HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings, New and Second-hand. Complete installations.
All kinds of Hydraulic Equipment in stock.

THOMPSON AND SON (MILLWALL), LTD., Cuba Street, Millwall, London, E.14.
East 1844/5. E111 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. Bexleyheath 305). E113 G

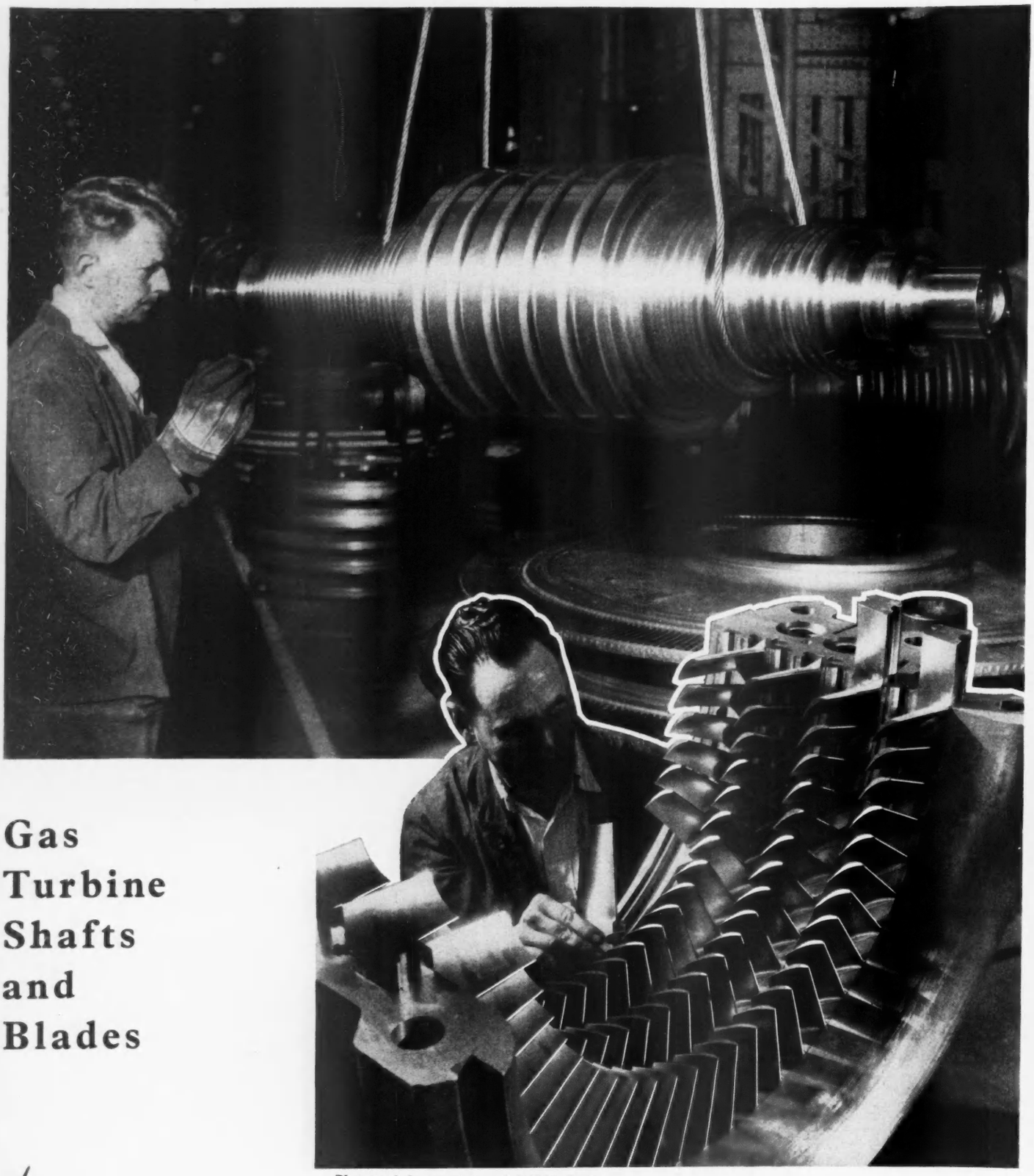
FOR SALE

7-TON MARSHALL ROLLER, Perkins P4 diesel complete with sprinklers. No. 90739. New 1946. In excellent condition. £875.0.0. loaded these works.
CHARLES JONES OF ALDRIDGE, LTD., Birch Lane Engineering Works, Aldridge, S. Staffs.
Tel.: Aldridge 52222. E9030 G

FOR SALE

5-ton capacity Anderson Grice, 3-motor, cab-controlled Overhead Electric Travelling Crane, 47ft. 9½in. span, electrics 440/3/50, new 1942.
5-ton ditto, 36ft. 3in. span, new 1942.
5-ton ditto by Heywood 31ft 3in. span, new 1942.

F. BURRILL & CO., 235a, Cathedral Road, Cardiff.
Tel. : 26100. E8914 G



Gas Turbine Shafts and Blades

Photograph by permission of B.T.H. Rugby.

by **FIRTH BROWN**

ALLOY STEELMAKERS · FORGEMASTERS · STEEL FOUNDERS · HEAVY ENGINEERS

THOS FIRTH & JOHN BROWN LIMITED · SHEFFIELD · ENGLAND

INDEX TO ADVERTISERS

PAGE

AB Atlas Copco/Sweden..... 41
A.C.V. Sales, Ltd..... 85
Abbott & Co. (Newark), Ltd.... 36
Adams, C., & Co., Ltd..... 22
Air Industrial Developments, Ltd..... 107
Aiton & Co., Ltd..... 118
Albion Engineering Co., Ltd... 104
Allen, A., & Son, Ltd..... 46
Allen, W. H., Sons & Co., Ltd. 49
Alley & MacLellan (Polmadie), Ltd..... 60
Anderson, C. F., & Son, Ltd.... 63
Anderson-Grice Co., Ltd..... 91
Arbuckle, Smith & Co., Ltd.... 59
Armstrong Siddeley Motors... 69
Armstrong Whitworth, Sir W. G., Aircraft, Ltd..... 54
Ash, J., & Son, Ltd..... 21
Ashton, N. C., Ltd..... 74
Ashworth Ross & Co., Ltd..... 93
Associated Lead Manufacturers, Ltd..... 8
Austin, E., & Sons (London), Ltd.. 130
Auto Aero, Ltd..... 122
Automotive Engineering, Ltd... 84
Automotive Products Co., Ltd. 32

Bailey, Sir W. H., & Co., Ltd.... 2
Barron, W. S., & Son, Ltd..... 19
Beecham Buildings, Ltd..... 82
Birfield Industries, Ltd..... 10
Birkett, T. M., Billington & Newton, Ltd..... 59
Blakeborough, J., & Sons, Ltd..... 87
Bochumer Verein..... 93
Booth, J., & Bros..... 6
Braby, F., & Co., Ltd..... 96
British Appliances Mfg. Co., Ltd..... 104
British Electrical Development Association..... 88
British Federal Welder & Machine Co., Ltd..... 123
British Industrial Engineering Co., Ltd..... 77
British Insulated Callender's Cables, Ltd..... 30
British Ropeway Engineering Co., Ltd..... 127
British Steam Specialties, Ltd. 113
British Thomson-Houston Co., Ltd..... 20
British Timken, Ltd..... Cover i
Broadbent & Co. (Rochdale), Ltd..... 130
Bronx Engineering Co., Ltd.... 124
Brookes & Adams, Ltd..... 107

PAGE

Broom & Wade, Ltd..... 64
Brown, D., Corporation (Sales), Ltd..... 115
Brown, Lenox & Co., Ltd..... 40
Brownlie & Murray, Ltd..... 113
Budenberg Gauge Co., Ltd..... 48
Bull, J., Rubber Co., Ltd..... 99
Bullows, A., & Sons, Ltd..... 143
Burnand, W. E., & Son, Ltd.... 114
Butcher, H., & Co..... 141

C. & M. Engineering Co., Ltd 55
Calorizing Corporation of Great Britain, Ltd..... 68
Carr, C., Ltd..... 35
Carter, B. & F., & Co., Ltd.... 127
Chance Bros., Ltd..... 76
Ciba (A.R.L.), Ltd..... 23
Cleveland Bridge & Engineering Co., Ltd..... 122
Clyde Crane & Booth, Ltd..... 6
Clyde Crane & Engineering Co 6
Cockburns, Ltd..... 38
Cohen, G., Sons, & Co., Ltd. 104
Colt Ventilation, Ltd..... 3
Cowlishaw, Walker & Co., Ltd. 42
Crane, Ltd..... 92
Craufurd Fabrications, Ltd..... 13
Crofts (Engineers), Ltd..... 72
Cross Manufacturing Co. (1938), Ltd..... 68
Cull, W. B., & Sons, Ltd..... 4
Curnon Engineering Co..... 55

Drysdale & Co., Ltd..... 15

Eagle Pencil Co..... 122
Eagre Construction Co., Ltd... 35
East Lancashire Chemical Co., Ltd..... 103
Easton & Johnson, Ltd..... 109
Electric Construction Co., Ltd. 99
Electro-Dynamic Construction Co., Ltd..... 130
Electronic Engineering..... 36
English Abrasives Corporation, Ltd..... 52
English Electric Co., Ltd..... 57
English Steel Forge & Engineering Corporation, Ltd.... 18
Evans, F. W., Ltd..... 51

Farmer, L., & Sons..... 141
Farrar Boilerworks, Ltd..... 130
Ferranti, Ltd..... 44
Filton, Ltd..... 109
Firth, T., & Brown, J., Ltd.... 142

PAGE

Fleming & Ferguson, Ltd..... 91
Flexible Ducting, Ltd..... 55
Fodens, Ltd..... 144
Follsain-Wycliffe Foundries, Ltd..... 141
Foord, J., & Co..... 141
Fordsmith, H., Ltd..... 42
Forster, T. S., & Sons, Ltd.... 104
Foyles..... 110
Fraser & Chalmers Engineering Works..... 102
Fraser & Fraser, Ltd..... 124
Freeman, Taylor Machines, Ltd..... 134
Fuller, Horsey, Sons & Cassell. 141

General Electric Co., Ltd...58–102
Gibson, A. L., & Co., Ltd..... 48
Girdlestone Pumps, Ltd..... 82
Glenboig Union Fire Clay Co., Ltd..... 51
Griffiths, Gilbart, Lloyd & Co., Ltd..... 55
Guest, Keen Iron & Steel Co., Ltd..... 25

Hadfields, Ltd..... Cover ii
Hall & Hall, Ltd..... 95
Hall Harding, Ltd.....Cover iii
Hall, J. & E., Ltd..... 45
Hallamshire Steel Co., Ltd..... 56
Hammelrath & Schwenzer..... 16
Harvey, G. A., & Co. (London), Ltd..... 71
Hayward, E., & Co. (Fabrications), Ltd..... 82
Head Wrightson Processes, Ltd 24
Hendry, J., Ltd..... 133
Herbert, A., Ltd..... 7
Higgs Motors, Ltd..... 37
Hill Top Foundry Co., Ltd..... 48
Hobson, H. M., Ltd..... 78
Hoffmann Manufacturing Co., Ltd..... Cover iii
Howard Pneumatic Engineering Co., Ltd..... 56
Hudswell Clarke & Co., Ltd... 36
Hunt & Moscrop, Ltd..... 107

Imperial Chemical Industries, Ltd..... 101
Ince Forge Co..... 110
International Harvester Co. of Great Britain, Ltd..... 132

Jellyman, S., Ltd..... 109
Jenkins, R., & Co., Ltd..... 27

PAGE

Kautex, Ltd..... 39
Kay & Co. (Engineers), Ltd..... 19

Lafarge Aluminous Cement Co., Ltd..... 34–111
Lambhill Ironworks, Ltd..... 79
Lanarkshire Bolt, Ltd..... 76
Lancaster & Tonge, Ltd..... 22
Lawrie, J. & T., Ltd..... 52
Lee, A., & Sons, Ltd..... 98
Lincoln Electric Co., Ltd..... 117
Lindemann Maschinenfabrik, G.m.b.H. 7
Lionweld, Ltd..... 74
Lloyd, R., Ltd..... 89
London Electric Firm, Ltd..... 16
Lynch, M., & Son, Ltd..... 46

Macfarlane Engineering Co., Ltd..... 125
Magnolia Antifriction Metal Co. of Gt. Britain, Ltd..... 124
Markland Scowcroft, Ltd..... 127
Marsden, S., & Son, Ltd..... 130
Marshall Fleming & Co., Ltd. 92
Mather & Platt, Ltd..... 39
Mersey Cable Works, Ltd..... 135
Metalastik, Ltd..... 9
Metropolitan Construction Co., Ltd..... 68
Metropolitan-Vickers Electrical Co., Ltd..... 83
Michell Bearings, Ltd..... 127
Mills, J., Ltd., Exors. of..... 131
Mirrlees, Bickerton & Day, Ltd..... 121
Moffat & Bell, Ltd..... 7
Mole, S., & Sons (Green Lane Foundry), Ltd..... 91
Mond Nickel Co., Ltd..... 73
Morgan Crucible Co., Ltd.....108
Morgan Refractories, Ltd..... 33
Morris, H., Ltd..... 12
Moss Gear Co., Ltd..... 35
Mudie's Electrical Co., Ltd..... 70

National Industrial Fuel Efficiency Service..... 46
Neal, R. H., & Co., Ltd..... 29
Neco Geared Motors, Ltd..... 26
New Welbeck, Ltd..... 81
Newalls Insulation Co., Ltd.... 123
Newbury Diesel Co., Ltd..... 110
Newman Industries, Ltd..... 120
Newton Collins, Ltd..... 89
Nitralloy, Ltd..... 68
Norris Brothers, Ltd..... 51

PAGE

Oakey, J., & Sons, Ltd..... 129
Oberman, J. H., & Sons, Ltd.. 21
Opperman Gears, Ltd..... 66
Opperman, S. E., Ltd..... 110
Osborn, S., & Co., Ltd..... 116

Parker, F., Ltd..... 105
Perry Chain Co., Ltd..... 43
Pinchin, Johnson & Co..... 25
Plenty & Son, Ltd..... 5
Plus Gas Co., Ltd..... 74
Pohlig, J., Aktiengesellschaft... 63
Polypenco, Ltd..... 75
Pool, J. & F., Ltd..... 127
Potter, F. W., & Soar, Ltd..... 22
Priest Furnaces, Ltd..... 97

Quasi-Arc, Ltd..... 62

Ransome & Marles Bearing Co., Ltd..... 31
Ratcliffe, F. S. (Rochdale), Ltd..... 114
Redman Tools & Products, Ltd. 15
Ross, R. G., & Son, Ltd..... 44
Rotork Engineering Co., Ltd... 21
Royal Show..... 55
Russ-Elektroofen, Kg..... 65

S.W.F..... 86
Salter, G., & Co., Ltd..... 112
Sandwell Casting Co..... 26
Sankey Green Wire Weaving Co., Ltd..... 106
Savery, T., Pumps, Ltd..... 67
Schieldrop & Co., Ltd..... 22
Schmitt, Ed., & Cie, G.m.b.H. 25
Scriven Machine Tools, Ltd.. 36
Shaw, J., & Sons (Salford), Ltd..... 128
Sheepbridge Equipment, Ltd.... 36
Sheffield Wire Rope Co., Ltd.... 51
Sheppard & Sons, Ltd..... 126
Slingsby, W., & Co., Ltd..... 86
Smedley Bros., Ltd..... 107
Smith Bros. & Co. (Hyson), Ltd..... 110
Smith & McLean, Ltd..... 67
Smith, T., & Sons (Rodley), Ltd..... Cover iv
Spencer - Bonecourt - Clarkson, Ltd..... 36
Spencer (Melksham), Ltd..... 11
Spiral Tube & Components Co., Ltd..... 133
Stanley, W. F., & Co., Ltd..... 103
Steele & Cowlishaw, Ltd..... 129

PAGE

Steel Construction Co., Ltd.... 81
Steel, J. M., & Co., Ltd..... 42
Steels Engineering Installations, Ltd..... 80
Stephens Belting Co., Ltd..... 86
Sterling Foundry Specialties, Ltd..... 119
Stone, J., & Co. (Charlton), Ltd..... 61
Strachan & Henshaw, Ltd..... 94
Sturtevant Engineering Co., Ltd..... 85
Suffolk Iron Foundry (1920), Ltd..... 95
Sulzer Bros. (London), Ltd..... 28
Sunvic Controls, Ltd..... 95
Super Oil Seals and Gaskets, Ltd..... 100
Sutcliffe, R., Ltd..... 134

Tangyes, Ltd..... 2
Taylor & Challen, Ltd..... 47
Taylor, F., & Sons (Manchester), Ltd..... 76
Thermal Elements..... 16
Thermal Syndicate, Ltd..... 113
Thompson, J., Motor Pressings, Ltd..... 14
Thorn Electrical Industries, Ltd..... 113
Tirfor, Ltd..... 106
Tonks, J., & Co., Ltd..... 36
Trewhella Bros. Pty., Ltd..... 92
Trumeter Co., Ltd..... 92
Turbine Furnace Co., Ltd..... 124

Ultra Electric, Ltd..... 17

V.W. Co., Ltd..... 67
Vokes Genspring, Ltd..... 128

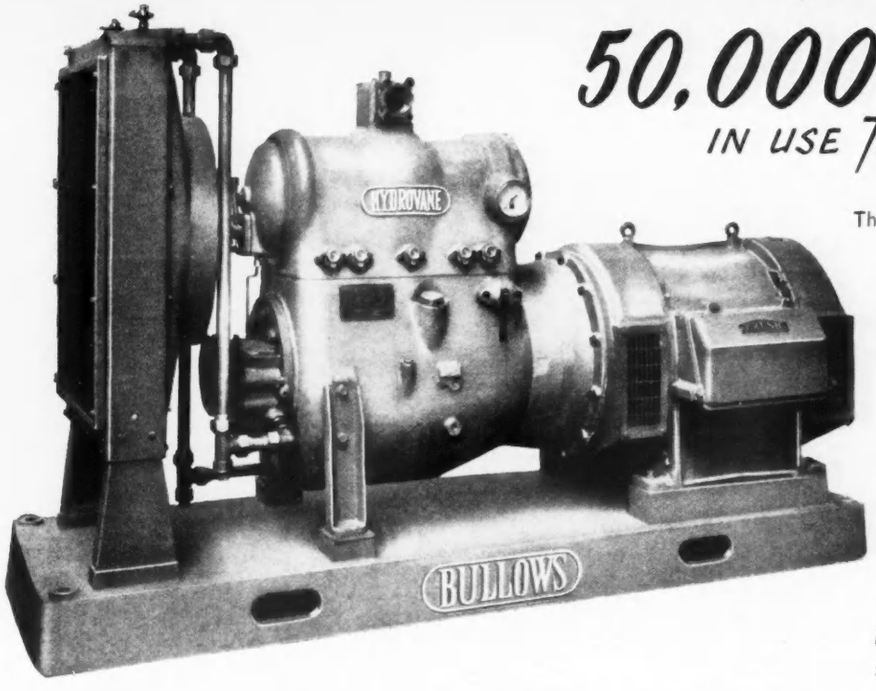
Walker Bros., Ltd..... 4
Ward, T. W., Ltd..... 140
Weir, G. & J., Ltd..... 53
West Yorkshire Foundries, Ltd. 114
Westwood Dawes & Co., Ltd. 26
Wharton Crane & Hoist Co., Ltd..... 50
Wheatley, Kirk, Price & Co.... 141
Wicksteed, C., & Co. (1920), Ltd..... 90
Wildbore, J. E., Ltd..... 22
Wilkinson Rubber Linatex, Ltd. 47

Yarrow & Co., Ltd..... 70
Young, J. S., & Co., Ltd..... 129

OIL-SEALED ROTARY COMPRESSORS

HYDROVANE BULLOWS

FROM 1/3-250 h.p.



50,000 IN USE throughout the World!

The Hydrovane principle was developed and introduced by Bullows in 1948 and has since been adopted by all the major manufacturers *throughout the World!*

10 Licencees manufacturing Hydrovane Compressors *throughout the World!*

For further details of the Hydrovane principle send for our "Questions & Answers" Folder

A. BULLOWS & SONS LTD · LONG ST · WALSALL · STAFFS · TEL. 5401

Foden

BY APPOINTMENT
MOTOR TRACTOR
MANUFACTURERS TO THE
LATE KING GEORGE VI

DIEU ET MON DROIT

40,000 LBS. PAYLOAD.

for Britain's Best Range of Dump Trucks

Stand 333
PUBLIC WORKS EXHIBITION
OLYMPIA . NOVEMBER 10TH-15TH

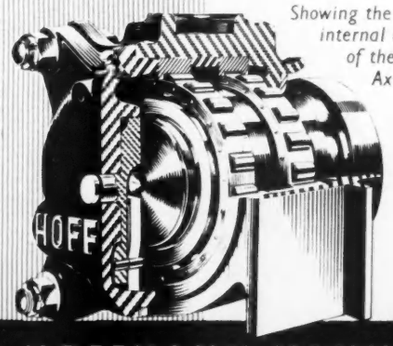
FODENS LIMITED . SANDBACH . CHESHIRE *London Sales Office:* 139 Park Lane W1 Telephone: Grosvenor 5932

1943 ®

PRINTED BY GEORGE REVEIRS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/1/0½

HOFFMANN

parallel
ROLLER BEARING
AXLEBOXES



Showing the internal construction of these Axleboxes

have been specified for the
LONDON TRANSPORT
PICCADILLY LINE
TO COMPLETELY EQUIP THE
532 HIGH CAPACITY PASSENGER CARRIAGES
of the All Silver finish to be built by Messrs. Metropolitan Cammell Carriage and Wagon Company Ltd.

A FURTHER INTERESTING FEATURE IS THE SPECIFYING OF HOFFMANN ROLLER BEARING TRACTION MOTOR SUSPENSION UNITS FOR EACH OF THE MOTOR COACHES

HOFFMANN AXLEBOXES AND SUSPENSION UNITS FIRST WENT INTO SERVICE ON LONDON'S UNDERGROUND AS LONG AGO AS 1935

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

for over 100 years...

We at Hall Harding have been steadily anticipating and fulfilling the needs of the drawing office. Today it is our proud boast that we can supply anything from a single photo copy to a complete print room, from a set-square to a complete drawing office. Small wonder then that for over a hundred years, Architects, Engineers and Designers have been getting in touch with Hall Harding.

HALL HARDING LIMITED
STOURTON HOUSE, DACRE ST., LONDON S.W.1

BRANCHES: BATH · BELFAST · BIRMINGHAM
BOURNEMOUTH · BRIGHTON · CARDIFF · DERBY
GLASGOW · HUDDERSFIELD · LEEDS · LONDON (4)
MANCHESTER · MIDDLESBROUGH, YORKS.
NEWCASTLE-UPON-TYNE · NEWPORT, MON.
PORTSMOUTH · ROMFORD · SOUTHAMPTON
STOKE-ON-TRENT · WOLVERHAMPTON

★ *Telephone: ABBEY 7890*

The Engineer

NOVEMBER 7, 1958

London-Yorkshire Motorway

*TWELFTH REPEAT ORDER

AMEYS AGGREGATES LTD., suppliers to John Laing and Son Limited on the London-Yorkshire Motorway, have taken delivery of a further two SMITH 21 Excavators, making the **TWELFTH REPEAT ORDER.** Increased production, by means of its long working radius and one-cubic-yard lightweight bucket, has made the SMITH 21 this firm's popular choice.

Smith 21 UNIVERSAL EXCAVATOR

THOMAS SMITH & SONS (RODLEY) LTD.
CRANE & EXCAVATOR WORKS · RODLEY · LEEDS